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Education/Training

MANAGER'S GUIDE TO NEW EDUCATION AND TRAINING TECHNOLOGIES

This handbook provides commanders and managers an overview of the communications and computer technologies of most interest to Air Force education and training. The handbook is written for managers who will benefit from a review of computer systems and the related technologies which have direct applications. It is also recommended reading for course developers, classroom teachers and trainers, producers of educational materials and job aids, and planners and administrators responsible for Air Force education and training.

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Chapter 1

MANAGERS AND TECHNOLOGIES

Overview

Purpose of This Handbook

This handbook is written for Air Force managers and is designed to do the following:

- Provide a personal foundation for understanding computer-related technologies.
- Show how the integration of technology enhances capability and potential.
- Focus on benefits of technologies to education and training.

This handbook is not an in-depth technical review. Computer scientists, engineers and technicians skilled in the technologies may not agree with all of the generalized conclusions of this mangement-level review. This handbook does not attempt to review or rate products, though specific products are mentioned to promote understanding of the technology.

Handbook Organization

Following opening chapters on the role of managers and an overview of the world of computer technologies, this handbook focuses on specific technology areas. Chapters include these sections:

Chapter Sections	Contents
Technology Quick-Look	A summary of the basic workings and issues associated with that technology
Terminology	Selected terms for clarification before reviewing the technology (a comprehensive glossary is in Attachment D)
Applications to Education and Training	Experience and ideas on the use of this technology for anyone in the field
The Technology	An expanded review of the technology and how it works
Advantages and Disadvantages	Summary highlights of the strengths and weaknesses of the technology

Useful References

The acronym and definition attachments in this handbook are designed for frequent reference. They will particularly help those readers who are not well versed in computer technologies.

Sources of Information for This Handbook

This handbook draws from the information presented by Ann E. Barron and Gary W. Orwig in their book, "New Technologies for Education" (Libraries Unlimited, Inc., Englewood, Colorado, 1993). Other information sources are noted in the text and cited in the Bibliography Attachment.

In This Chapter

The sections in this chapter form the foundation of the manager's dealing with technologies:

Section A
Technology's Role in Education and Training

Technology Integration

Technology is an integrated and accepted part of American society. The popular saying that "the world is shrinking" summarizes the impact of technology in making more information readily accessible and easier to transmit. One of the most important skills taught to students of all ages is the ability to use technology to access, analyze, filter, and organize the overwhelming flow of information.

Education's Acceptance of Technology

The Air Force education and training communities, as part of the world's most technological air force, have made halting progress in integrating and adapting available communications technologies into the instructional programs. The restraints that limit full technology infusion into education and training are similar in the military and in civilian educational institutions:

- "Mistrust of the unknown" that many experienced and respected educators, trainers, and managers have for technology.

- Difficulty of comprehending the constantly changing, detail-demanding, and often oversold capabilities of the technologies offered as "tools."

- A frequently shared opinion that use of technology in the educational setting is a surrender to the entertainment media. "Why should video be used in the classroom¾shouldn't the teacher be teaching instead?" This narrow view ultimately denies teachers the use of valuable instructional tools.

- Lack of sufficient training for teachers, instructors, course designers, and managers in the understanding and implementation of technology tools.

- Insufficient studies that can effectively demonstrate the learning enhancements and cost efficiencies of technology-supported courses.

- High front-end costs associated with computers and other communication systems.

Potential Benefits from Technology for Education and Training

Researchers continue to investigate the effectiveness and efficiency of a broad range of computer-based instruction, generally involving multimedia and telecommunications (see Chapter 2 for discussion of these technologies). The complexity of multimedia¾ delivering information in many media at once¾complicates the research process. The following initial observations are supported by current literature in the field.

Observation	Meaning
Multisensory delivery	Research in learning styles shows that some students learn best from audio, some from visual, some from touch. Multimedia instruction tends to assist more students.
Self-expression and active learning	Technologies provide stimulating environments for students to be active in the learning process. Active involvement on the part of students results in many positive effects.
Cooperative learning	Technology provides more opportunities for students to work cooperatively. Some multimedia programs can serve as manager, organizational base, advisor, and evaluator of the group activities. Teachers have implemented cooperative learning with technology-supported activities and report an increase in instructional effectiveness and efficiency and positive social interactions.
Communication skills	The use of computer networks to go beyond the classroom can provide unique opportunities for students to practice, demonstrate, and critique communication skills. Computer-based telecommunications can particularly benefit instruction in problem solving, decision making, and other critical thinking skills.
Motivation	Technology promotes interest and motivation for students and teachers by making learning exciting and relevant. Research shows that students react positively to the integration of technology and therefore stay on tasks for longer periods.

Technologies for Education and Training

The technologies of most immediate benefit to education and training are communications and computer technologies. Those technologies merge in the form of what is generally referred to as multimedia.

Definition of Multimedia

In its narrowest sense, "multimedia" means the integration of two or more media with a personal computer. The media list includes audio, video, text, graphics, and animation. The latest technologies even add odors. The dynamic growth of many technologies, including the integration technologies that bring the diverse systems under the precise control of a personal computer, offer extremely powerful tools in many fields, especially education and training.

Why Focus on Multimedia?

Multimedia should be viewed conceptually as a convergence of communications technologies into a coordinated system controlled by the user. The following applications appear to benefit most from continuing advancements in multimedia:

- Interactive training
- Personalized education
- Public information systems
- Consumer entertainment
- Commercial promotions and sales

Implementing Technologies

Integrating technology into education and training is a complex process. The experience factor suggests the following:

Suggestion	How It Can Help
Determine goals first, then add technology support.	Establishing instructional goals and objectives first, then selecting supporting technology, helps define if and what technology will be effective.
Ask questions.	Advances in technology are constant and overwhelming. No one has all the answers. Ask colleagues, other professionals, vendors, and students.
Visit other schools.	Most educators and trainers are willing to share their successes and lessons learned. In addition, some states and civilian schools and large corporations have established experimental "model technology schools" to test implementation techniques.
Attend training sessions.	Go to workshops that emphasize hands-on training, provide well-planned materials for future reference, include lesson integration strategies, and promote interchange with other educators and trainers.
Subscribe to periodicals.	Publications keep up with the latest developments in research, integration ideas, and product reviews.
Involve the students and use their expertise.	Student involvement provides valuable assistance for the teacher and helps build students' self-esteem.

Continued

Suggestion	How it can Help

Investigate public domain and shareware sources.	Public domain software is available at no cost and may be freely copied. Shareware often offers an outstanding value for a minimal cost paid to the program author.
Analyze the training materials before purchase.	Quality documentation and tutorials can alleviate much of the frustration involved with installing and learning new products.
Investigate technical support.	Access to quality technical support is invaluable. A toll-free number is important.
Balance "high tech" with "high touch."	Teachers can use technology as another tool for presenting and providing access to knowledge, but teachers remain the essential human element, providing the "high touch" of compassion and understanding for individual students.

Section B
A Manager's Approach to Technologies

Manager's Role Regarding Technologies

Air Force managers who evaluate, select and guide the application of technologies should:

- Have a basic understanding of the technologies.
- Consider and integrate all aspects, including the opinion of the technical experts.
- Maintain the focus on the mission.
- Make decisions; there will never be a better time to decide about technology.

Integrating Diverse Judgements

Applying powerful technology tools to the tasks of educating and training inevitably involves many experts of diverse background and opinion: some are technical, some are artistic, some are business-oriented. Although all of these team members are well- intentioned and versed in the needs and details of their roles, the manager remains the decision maker.

Maintaining Mission Focus

The most useful rule for the manager is: maintain the focus on mission accomplishment. Evaluate the technologies in terms of the education and training of Air Force students.

Chapter 2

A REVIEW OF ENABLING TECHNOLOGIES

Overview

Introduction

This chapter presents information, terminology and concepts common to the applications. More detailed looks at technology applications are given in the following chapters.

In This Chapter

These sections set the stage for discussions on technology applications:

Section A
Lasting Impact of Television and Computer Technologies

Television and Computers

The impact of the technologies incorporated in these two applications will be noted by historians as major shaping forces of the 20th century. Their impact has revolutionized communications and all of its related fields and activities. Education and training have begun the transition, building an understanding and acceptance of the technologies as tools useful to the profession. The appropriate infusion of technology is an unending, inevitable process.

Technology/ Application		Value
TELEVISION	Video	Provides the power and impact of visual images. Developments include ability to convert analog signals to digital data, thereby allowing computer storage, editing, and quick retrieval. Progress sought in areas of improved resolution and colors, in reducing massive storage requirements, in adding video capabilities to desktop computer systems and for consumer uses.
	Audio	Provides the power and impact of sound, including speech and music. Developments include major improvements in digitizing what is esentially an analog medium in nature. The MIDI, for Musical Instrument Digital Interface, connects musical instruments to computers. Digital audio systems sample and represent sound as data usable by computers. Resolution, editing, storage, reproduction, and durability of audio discs and playback systems have all improved.

COMPUTERS	Telecommunications and Networks	Provides the electronic links that negate distances. Video, audio, text and graphics originated on the next desk or around the world can be shared for almost instantaneous use or to be stored, reworked, and called up when convenient and as often as the users like. Group collaboration on productions no longer requires the experts to gather at one site.
	Processors	Provides the data processing power which is the core of every computer system. Developments in processing power and speed, in miniaturization, and in standards leading to compatibility between systems¾all combine to be a "brain" to accurately control the many other elements of the system.
	Output Devices	Translate the data from the processor into forms usable on printers, audio speakers, computer and television monitors, through modems to remote computers, and to any of several storage devices, either electromagnetic or optical. Developments include digital-to-analog converters, decompression technologies, improved monitors and audio systems, and a multitude of editing and manipulating systems which present the data in the most effective, specialized format.
	Input Devices	Provide the means to capture and reformat data into digital format for processing by the computer. Devices include keyboards, scanners, mice, cameras, joysticks, and microphones. Developments include analog-to-digital converters, data compression technologies, and industry standards.
	Storage	Provide the capability to organize, retain and provide selective and instant access to the wealth of data used in the computer system. Developments include greatly increased capacities in analog and digital storage in both electromagnetic and optical formats, and laser beam write and read capabilities.

A Framework for the Technologies Involved

It is helpful to use television and computers as a framework in which to display the basic technologies that are most applicable to education and training. The following table summarizes the technology areas and their impact values. More in-depth infor- mation on these technologies and how they work is found in Chapters 3 through 9.

The Human Analogy

It can also be helpful to relate a computer system to parts of the body, as shown below.

Function	Computer System Element	Human Body Element
Data processor and storage devices	Processor	Brain
Output devices	Printers, speakers, visual screens	Voice, touch, thoughts, memory
Input devices	Keyboards, scanners, mice, cameras, joysticks, microphones	The five senses
Connections and circuits	Electronic circuits, cabling	Nervous system
Behind the scenes control of "auto" functions	Read-only memory (firmware which controls low-level system function)	Subconscious controlling of breathing, blood circulation, etc.

Interprets, uses, edits, stores data	Random-access memory	Active memory

Section B
Useful Basics About Technologies

Basics About the Technologies

From the framework and discussions in the previous section, this handbook now reviews some basic characteristics and underlying concepts of the technologies. These areas will be covered in this section:

- Hardware and software
- Analog and digital
- Electromagnetic and optical
- Computers
  - Personal/ Mainframe
  - Boards, cards, peripherals
- Storage and memory
  - Hard disks
  - Floppy disks
  - Compact discs
  - Video discs

Hardware and Software

A basic categorization of the many elements of a computer system is a distinction between hardware and software.

- **Hardware** includes everything tangible¾that physically exists. This includes the processor unit, disk drives, cabling, boards or cards that are mounted internal to the processor, and peripheral devices such as printers, keyboards, compact disc players, and modems.

- **Software** includes everything else¾the conceptual and intellectual properties such as data, programs, and operating systems. Some software permanently resides in the computer system to control low-level functions and operations; this is called **firmware** or **read-only memory**.

Analog and Digital Electronic Media

There are two basic media in which electronics function:

· **Analog** signals are continuous and smooth fluctuations, like waves of water. Most things in nature are analog form, including light and sound and electromagnetism. Because electric current also flows in analog form, early electronics were developed in analog.

· **Digital** signals are represented by numbers. Each value is a discrete step, rather than a smooth variation as in analog. Most modern electronics are developed as digital systems, allowing exacting data and control over processes. The greater manipulation of digital data also assists in the reduction in size of represented data.

Most multimedia equipment today has both analog and digital components. The ability of the two systems to convert back and forth is one of the major achievements in electronics in recent years.

Electromagnetic and Optical Media

Nineteenth-century scientists discovered the relationship between electricity and magnetism and defined **electromagnetism**. Essentially, electromagnetism in various forms is the basic principle behind the electric motor, transformers, and some other components of audiovisual equipment. Magnetic patterns can be recorded on certain surfaces for later reading by a playback head. This is the basis for audio and video tapes and for floppy disk and hard disk storage media used with computers.

The trend in storage media is toward **optical media**, which owe their existence to the laser. Optical media are created by focusing a laser beam on a very precise area of a plastic disk and turning the laser on and off several million times a second, thereby creating a representation of bits of data. This stored data is read by another laser beam for playback. (Later chapters compare the media advantages and disadvantages.) The following table lists examples of magnetic and optical media.

Magnetic Media	Optical Media
Audio tape	Audio compact discs
Videotape	Compact disc read-only memories
Floppy disks	Laserdiscs, videodiscs
Hard disks	Fiber optics

Computers

Computers have evolved from vacuum tubes to transistors to integrated circuit technologies. The term "computer" has been popularized to include the hardware and software programs. It is helpful for managers to remember that computer hardware systems still consist of four primary elements: input device, memory system, central processing unit, output device.

Computer Categories

There are several loosely defined categories of computers, ranging from **mainframes** through minicomputers and workstations to **personal computers**, or "PCs." The categories are based on performance and volume capabilities, and those are changing daily. At the time of this writing, high-end mainframes can perform 2,000 million instructions per second (MIPS); personal computers can perform 1 to 3 MIPS.

Computer Hardware Trends

The movement today in industry and business applications is away from mainframe, centralized computer centers to decentralized operations. The growth in power and performance and networking capabilities of PCs makes them satisfactory for most computer applications. This applies to most education and training applications.

Boards, Cards, and Peripherals

Existing computer hardware systems are made more useful for specific functions by the addition of **boards**, a collection of integrated circuits and other electronics mounted on a thin material sheet. A **card** is the same as a board. Boards are essentially **peripheral** devices, except that they are mounted into slots in the processor box. The boards can be used to add input or output features to the system. For example, a board may have to be added to convert the computer's digital output into analog signals for display on a color monitor. Peripheral devices are normally devices which are external to the computer and cabled to the unit.

Standards for Multimedia Computers

Newly developing standards for multimedia computers are important for managers to know because education and training applications are now or soon will be multimedia programs. Developed by Microsoft and adopted by an industry group known as the Multimedia PC Marketing Council, the Multimedia Personal Computer (MPC) standard is a set of guidelines which dictate minimum configuration of a computer system that will be used for multimedia applications. The second generation of the MPC standard was announced in mid-1993 for advanced multimedia programs.

Multimedia PC Specifications		
Requirements	**Level 1**	**Level 2**
Random Access Memory (RAM)	2MB	4MB
Processor	16 MHz 386SX	25 MHz 486SX
Hard drive	30 MB	160 MB

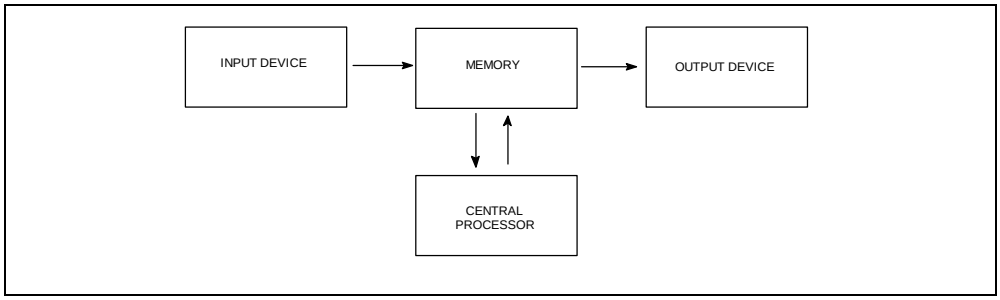

Figure 1. Hardware Components of a Computer

Compact Disc-Read Only Memory (CD-ROM)	150 KB/sec sustained trans. rate, max. avg. seek time 1 sec.	300 KB/sec. sustained trans. rate, max. avg. seek time 400ms. CD-ROM XA ready, multi-session capable
Sound	7-bit digital sound, 8-note synthesizer Musical Instrument Digital Interface (MIDI) playback	16-bit digital sound, 8-note synthesizer, MIDI playback
Video display	640x480, 16 colors	640x480, 65,536 colors
Ports	MIDI, I/O, joystick	MIDI I/O, joystick

Understanding MPC Standards

The specifications and recommendations in the MPC standards will have more meaning for managers after reading this volume. The standards will become a reference list for managers checking on computers recommended for new applications in their areas of responsibility.

Storage and Memory

Computers have two types of memory: random-access memory (RAM) and read-only memory (ROM).

· **RAM**. Random-access memory is where the data and programs reside while being worked on. Each location on the RAM device is accessible, and the ability to read the data at any location is part of the computer's power to "think." Essentially, each location contains one type of data. RAM is active only when the computer is turned on.

· **ROM**. Read-only memory allows the computer to read data from it but not write new data to it. ROM is most often used for storing the operating instruction for programs (instructions which should not need changing) and for programs intended for playback, such as audio and video files.

Memory Capacity

Massive amounts of memory are needed for multimedia, because the data files are large for quality sound, graphics, and video. The more memory, the better.

Hard Disks and Floppy Disks

All disk drives use a platter which spins like a record on a turntable. The platter has concentric rings, called tracks. The rapidly spinning disk is read by an electromagnetic head that moves in and out on a radius from the center. Thus, any area on the disk is equally accessible. These disks are in two forms:

· **Hard disks** are disks coated with ferrous particles that can be controlled as magnetic fields. In PCs, hard disks are designed to remain installed in the computer's hard disk drive unit.

· **Floppy disks** are magnetic disks about the thickness of photographic film. They are encased in a protective jacket with an opening through which the head can read the data on the spinning disk. The first floppies were 5.25 inches square. They are now being replaced by 3.5-inch square disks encased in a plastic jacket, and are no longer "floppy." The smaller disks hold more data and are more durable. Computers must have separate disk drives for each disk format. Floppy disks are easy to transport and store outside the computer.

Optical Discs: Compact Discs and Video Discs

These discs are mass storage media. They differ from electromagnetic disks in that optical discs use laser technology to write data in very minute spaces on a plastic disk, essentially etching the disk so that another laser can shine a light into the data area and read the reflection as data.

Note that optical media discs are spelled with a "c" and electromagnetic media disks are spelled with a "k." Optical media discs come in two varieties:

- **Compact discs** are 4.72-inch-diameter plastic discs and are mass storage devices used in music playback systems and with computers for storage of audio and visual data for multimedia. (See additional detail in Chapter 3.)

- **Videodiscs** are 12-inch-diameter plastic discs and are used to store the large amount of data needed for motion video and sound. (See additional detail in Chapter 4.)

Storage

Data not currently being worked on by a computer is stored on a hard disk in the machine, or on a compact disc or video disc either in the machine or external to it. Stored information cannot be accessed as quickly by the computer as can data in the RAM. This access and play rate limitation can degrade the capability of some multimedia programs, such as the frames-per-second playback rate.

Section C
Trends and Reminders

Rising Expectations

A major result of the public's instant access to endless information and the computing power to edit it into specialized, high-energy communications is that the public now expects high-quality, instantaneous, tailored, multimedia delivery of most information. Unfortunately, this has the effect of discouraging many beginning users of the communications technologies, including many people in the education and training arenas.

Power to Communicate

The power to communicate in today's society is broadening beyond the individuals who control the mass media. Much of that power is being actively sought and exercised by individuals and groups skilled in dynamic communications and computer technologies. The more educators and trainers who master these skills, the better tomorrow's instruction will be.

Need for Technology Experts

Managers are reminded of the importance of having an expert available to research, design and advise on matters of technology. Educators and trainers are not expected to be adequately versed in the intricacies of computer technology, any more than a computer scientist can be expected to research, design, develop and deliver instruction. The prevention of costly errors in selection and application of computer systems will more than pay for the time of an expert.

Technology Not Education or Training

Educators and trainers must also remember that, for all the enhancements possible through the infusion of appropriate technologies into instruction, technology remains only a tool. Technology is not education. Technology is not training. However, the educator or trainer who fails to employ the best tools will soon fade into mediocrity in his or her field.

Trends to Follow

Current trends in communications, education and training technologies can be discerned and should be followed. Insight in these areas helps decision makers position their operations for future capabilities. Some of the trends seen by multimedia author and expert Jeff Burger (1993) are:

· Computers and television technologies will combine, blurring any meaningful distinction.

· Teleconferencing, networking, even virtual environment technologies will merge into the multi-faceted communications giant. Witness the current rush by these industries to team with partners in related companies.

· Sophisticated communications technology will concentrate on providing just-in-time, embedded training or refresher tutorials to workers beginning difficult tasks.

· All desktop and portable computers, in business and home, will be multimedia-capable.

· Emphasis will continue toward automating development and production processes, making it easier for new users to use more of the power in the technologies.

Chapter 3
COMPACT DISC TECHNOLOGIES

Technology Quick-Look

Compact discs, or CDs, are:

- Applications of optical media technology.
- Mass storage devices for data:
  - One storage format is widely used in music playback systems.
  - Another format is used in or with computers as storage for data and multimedia such as sound and visual playback.
- Small (4.72-inch diameter) plastic discs.
- Durable, easily transportable, inexpensive to mass-produce.
- Read by laser beam, therefore do not wear out with use.
- Read-only and currently cannot be modified or updated by the user.

History

Technologies maturing in the 1970s led to audio CDs that gained consumer popularity in the 1980s. They were used only for audio playback; for example, for music and book texts read for the visually impaired or for commuters driving in their autos.

Compact Disc-Read Only Memory (CD-ROM) technology is a natural technological extension of the audio CD. CD-ROM technology is impacting the computing world, including applications for education and training. CD-ROMs are read-only, that is, the information on the disc is permanent and cannot be modified or erased.

CD and CD-ROM Terminology

Note that the terms designate different systems. Although both systems use a compact disc storage device, most users use "CD" or "Compact Disc" to denote the system popularized to play back music or spoken text. The term "CD-ROM" is used to denote the computer package (computer, software, drive, disc) which uses the compact disc storage device. CD-ROM has also come to mean the hardware and software package required in a computer system to use the CD-ROM software program.

A CD-ROM system can play back the audio and very limited graphics stored on a CD. A CD player cannot deliver the full information stored on a CD-ROM disc.

In This Chapter

You will find information about CD technology in the following sections of this chapter.

Section A
Applications to Education and Training

Introduction

A CD-ROM disc can store information in a variety of formats, many of which offer valuable educational and training assistance. The combination of large storage capacity plus search capability makes CD-ROM applications useful in many applications, including:

- Reference sources
- Databases
- Multimedia products
- Computer software

Reference Sources

One of the most useful applications is for reference sources. The large storage capacity allows storing text, charts, graphics, pictures, video and sound on a single disc.

Entire encyclopedia contents can be stored on a single disc. The power of an electronic encyclopedia lies not only in the rapid access to a particular article, such as aircraft, but in the ability to use aircraft as a keyword, thereby finding every occurrence of that word in the encyclopedia.

Examples

Air Force educators, trainers, courseware developers, and researchers can use the power of CD-ROM references to access reference materials, to electronically make available to every student every Air Force manual, handbook, policy statement, and technical order. The following commercial examples may also be of value:

· *Information Finder* by World Book does not currently provide sound or graphics; however, it does offer competitive pricing, powerful search techniques, and a fast and efficient interface. Furthermore, the *World Book Dictionary*, with over 140,000 definitions, is available from within the encyclopedia.

· *Microsoft BookShelf* by Microsoft loads into the memory of the computer and stays in the background while another computer program, such as a word processor, is running. *Microsoft BookShelf* reference materials can be called up at any time (without closing the word processor). They include the *American Heritage Dictionary*, the *World Almanac, U.S. Zip Code Directory, Roget's Thesaurus, Bartlett's Familiar Quotations*, and *The Chicago Manual of Style.*

· Several encyclopedias are available, all of which provide a fast, efficient alternative to manually searching an encyclopedia. *Grolier's Multimedia Encyclopedia* is now available for both Macintosh and IBM-compatible computers and includes sound, pictures, and powerful search techniques.

· The *Compton's Multimedia Encyclopedia* offers, instead of the customary text entry screens, a hypermedia interface through which users click on an icon to access an area of interest. *Compton's* also offers several alternative access routes to information. For instance, in addition to typing in a search word, users can navigate through a picture catalog, investigate an area in an atlas, or choose a period of history on the timeline. Whichever route is taken, links are available to obtain the text of each article.

· The *Webster's Ninth New Collegiate Dictionary* by Highlighted Data will pronounce words and do much more. *Webster's* contains all the features of its print edition (over 200,000 definitions) plus entry words pronounced by a human voice, an option to change the display size to large type for easy reading, and the ability to jump from one place to another to check cross-referenced words.

Databases

One of the most important applications for CD-ROM technology is the storage of large databases. Prior to CD-ROM, databases were usually stored in huge indexes in libraries or mainframe computers. Computers and modems could be used to access the mainframe computers, but the expense was high and many facilities and schools did not have the necessary equipment or telephone lines.

Most indexes now available on CD-ROM do not contain the full text of the articles. Instead, they provide the author, title, journal, year of publication, and an abstract. The user can read the abstract or save the information to a diskette.

Examples

Air Force users of CD-ROM databases include not only education and training developers, but the students themselves. Making available and convenient masses of technical information serves everyone from technicians on the flightline to planners and acquisition staffs at the headquarters. Some current applications available from sources external to the Air Force include the following:

- The Education Resources Information center (ERIC) is a national bibliographic database for educational literature. ERIC references over 775 professional journals and 300,000 documents from other sources, such as conference papers and research studies. Several companies supply search software for ERIC and distribute the database on CD-ROM.

- *Periodical Abstracts*, by University Microfilms International, provides citations and abstracts to articles in over 300 general and reference periodicals in the areas of arts, business, science and computers, health, news, lifestyles, commentary, education, literary and political reviews, consumers, and social issues.

- SIRS (Social Issues Resources Series) is a service that provides timely information from newspapers, magazines, government publications, and journals. Permission has been obtained by SIRS for reprints, so full text can be downloaded to disk or printed. Abstracts are provided for any articles that are not available for replication.

Multimedia Products

CD-ROMs can store as digital data the information presented as text, graphics, sound, video, and animation. With these capabilities, CD-ROM has become a major medium for multimedia products. Integrated with a computer system, CD-ROM's storage capacity enables interactivity in training programs in a wide variety of subjects.

Examples

The Air Force has added the power of CD-ROM to some of its performance improvement programs that bridge to include the function of on-line training. One project for the San Antonio Air Logistics Center uses two CD-ROMs linked to the computer to provide Federal Stock Numbers and military parts numbers for the thousands of electronic cables and connectors used in aircraft systems. The identification and training system is computer-based and on the computer's hard disk. The computer system accesses the CD-ROMs to find and import appropriate data.

Many commercial companies "publish" CD-ROM products for consumer, education and training applications. In addition to adding sound and visuals to previously print-only information sources (for example, encyclopedias), the multimedia products are credited with getting and sustaining students' interest for learning.

Computer Software

CD-ROMs store computer information and are an ideal medium for distributing computer programs. One CD-ROM can replace approximately 750 computer diskettes. Distribution via CD-ROM is advantageous because it is read-only; no one can erase a CD-ROM by mistake.

Examples

The *Personal Computer Special Interest Group Library* contains hundreds of IBM shareware computer programs. The software with the CD-ROM allows you to search for computer programs related to a particular topic or age level. After a program is selected, it can be previewed on the CD-ROM. If you find a program you want to use, you are allowed to copy it from the CD-ROM to a computer diskette. Most programs request that a small contribution be sent to the developer if the program is used.

PD ROM is produced by the Berkeley Macintosh Users Group (BMUG). It contains more than 600 megabytes of publicly distributable software, with over 7,000 individual files such as HyperCard stacks, graphics, and games.

Section B
Hardware Considerations

CD-ROM Capacity

The capacity of one CD-ROM disc exceeds 650 megabytes, which is equivalent to several hundred diskettes or the entire text of a 20-volume encyclopedia or two and a half years of issues of the *USA Today* newspaper. In the Air Force, the entire contents of the technical orders for a major weapon system can be stored on a disc or two.

Storage Device	Capacity	Equivalent Pages of Text

Floppy Disk	0.72 MB	360
Hard Disk	200 MB (larger systems exceed 1000 MB)	100,000
CD-ROM	650 + MB	250,000

Hardware Considerations

In its simplest form, a CD-ROM delivery system consists of these elements:

CD-ROM System Element	Function
CD-ROM drive	Reads the digital data stored on the disc. Drives may be built-in or external.
Controller	Controls the drive and interfaces with the computer. Many newer CD-ROM drives have built-in controllers.
Search engine	Consists of a microprocessor, memory, and software. Interprets user requests and responses and generates instructions for the controller.
Input device	Takes the user's request and responses. Typical devices are keyboards, touch screen, mice, joysticks.
Output device	Displays to the user the information taken from the disc. Typical devices are computer monitors, CRT displays, television sets and audio outputs, LCDs (liquid crystal displays used on portable computers), printers, data-encryption devices, and image compression and decompression devices.

Operating a CD-ROM

To read and display the information on a CD-ROM disc, a CD-ROM player must be connected to a computer. The computer can read the data on the CD-ROM disc as if it were a hard drive. In other words, you can do a directory listing or even copy files from the CD-ROM disc to a diskette or hard drive. To provide efficient access to the information on the disc, most CD-ROM applications provide software programs to search and retrieve the desired information. This software may be located on the CD-ROM disc or it may be provided on diskette.

Playing CD-ROM on IBM and Compatibles

CD-ROM players can be used with IBM and compatible computers. The players can be internal in the computer or external drives connected to the computer.

CD-ROM applications must be compatible with the monitor on the computer system.

· If the CD-ROM program includes color graphics, a VGA (video graphics array) monitor is usually required.

· If the CD-ROM program is text-only (few are), a monochrome or CGA (color graphics adapter) monitor will work.

If the CD-ROM player is external to the computer, these considerations apply:

· An additional card (board) must be installed in the computer. The interface cable connects the player and the internal card.

· A software program, usually Microsoft Extensions, must be added on the computer's start-up drive. This allows the computer to communicate with the CD-ROM player as if it were an additional hard drive.

Playing CD-ROM on Macintosh

A CD-ROM player can be used with any Macintosh computer. Most CD-ROM players for Macintosh are external devices. These particulars apply:

· The connection is through the Small Computer System Interface (SCSI) port on the back of the computer.

· The connecting cable is generally included with the purchase of the CD-ROM player.

· Access files on the CD-ROM disc must be loaded into the Macintosh start-up system software. The files provide the software protocol necessary for the computer to read the data on the CD-ROM.

· For audio output, CD-ROM players usually include a headphone jack and output connections for external speakers

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A CD-ROM Audio Note

Audio can be captured in, stored, and replayed from a digital format. CD-ROM's ability to combine audio and visual outputs in the same program is a major strength of the system. To create the audio output requires a sound-processing board in the computer and either headphones or speakers.

CD-ROM systems can play audio from both the CD-ROM formatted disc and the CD-digital audio disc (the popular music disc). However, CD-ROM discs cannot be played in a CD-audio player.

Jukeboxes

A jukebox is a CD-ROM player that will hold more than one disc, usually four to six. The needed disc is accessed through the software control of the computer.

Networking CD-ROM

It is possible for several computers to share a CD-ROM if the appropriate hardware and software are connected to a network. These are considerations:

- The system can be accessed throughout a classroom or even a school.
- Multiple users can significantly slow the response time.
- CD-ROM applications must be network-compatible if they are to operate properly for multiple access.
- A multiple-use license is required.

Caddies

Some CD-ROM players require that the disc be placed into a caddy before insertion into the player. The caddy, which holds a single disc, assists the player in handling the disc. Caddies are relatively cheap and should be purchased in a quantity that allows storing the discs, even when not in use. Caddies are usually interchangeable among players.

Section C
CD-ROM Advantages and Limitations

Impact of CD-ROM Technology

Although CD-ROM technology offers many educational and training benefits, it is not appropriate for every program. The following features and limitations are to be considered:

Advantage	Impact
Storage capacity	Each disc can store 683 megabytes of data, graphics or sound. That capacity is equivalent to hundreds of floppy disks.
Portability	Discs are small and lightweight, an ideal medium for transporting data.
Durability	Discs are very durable. Fingerprints and slight scratches will not usually impair their performance. Discs are read with a laser beam, so there is no direct contact or wear on the disc as it is played.
Low cost of replication	Reproduction costs only pennies after the master is created.

Inexpensive hardware	The cost of CD-ROM drives has decreased dramatically in the past few years. Many computers now feature built-in drives.
Availability of CD-ROM programs	Several thousand commercial titles now available include a wide range of reference materials, multimedia applications, and government documents.
Speed	Although the access time of CD-ROM drives is slower than that of hard drives, the speed of the search time compared to manual methods is very impressive.

Limitation	Impact
Slow data access	CD-ROM drives can access data in about 350 milliseconds, but this is still 20 times slower than a hard drive.
Cost of subscriptions	Some CD-ROM programs, including education and training applications, require a subscription fee for updates. These fees can often be as much or more than the original purchase and should be budgeted as a life cycle cost.
Limited scope	Even though CD-ROMs hold an enormous amount of information, they are limited. If an application requires more than one disc, a multiple-disc player is required.
Read only	CD-ROM discs cannot be changed. Although this may sometimes be an advantage, it complicates the revision and update process.

Section D
Commercial Applications from CD-ROM Technologies

CD-ROM Standards

The success of CD-ROM technology has created many spin-off technologies and applications. Each new product incorporates the CD-ROM compact disc. Earlier difficulties with lack of standardization of formatting of instructions and data on the discs have been largely resolved.

CD-ROM standards began with what the industry calls the "Yellow Book," developed by Sony and Phillips corporations. These standards ensure uniform frame and sector architecture and levels of data encoding and decoding. However, the issue of cross-compatibility between players and computer platforms was not addressed in the standards. This was resolved in what is now called the "High Sierra" standard which organizes files and indexes so that they can be accessed universally. As explained in Burger (1993): The result is that any computer that has a driver than can translate between its operating system and the High Sierra standard can locate and access any file on a High Sierra CD-ROM disc. Note that the data in the files on the disc must be in a form compatible with the given application for the contents to mean something. In other words, managers purchasing CD-ROM programs should ensure that the disc is formatted for their platform, either PC or Macintosh.

Commercial CD-ROM Applications

The following is a sample of CD-ROM technology applications.

Product	Abbreviation	Responsible Manufacturer	Application
Compact Disc Interactive	CD-I	Philips	Interactive audio, video, and computer system based on compact disc for storage. Players have a built-in computer. Output will display on television set. Consumer-oriented.
Commodore Dynamic Total Vision	CDTV	Commodore	Multimedia delivery system that combines digital audio, graphics, and video on a compact disc. Will display on a standard television set. Does not require an external computer. Entertainment and educational titles for the consumer market.

Continued

Product	Abbreviation	Responsible Manufacturer	Application
Video Information System	VIS	Tandy-Microsoft	Home interactive compact disc players. Player contains a built-in computer.

Digital Video Interactive	DVI	(a technology)	Compressing and decompressing video and audio to create multimedia applications. Can store 72 minutes of full-motion video on a compact disc.
Compact Disc - Read Only Memory eXtended Architecture	CD-ROM XA	(a technology)	A special CD-ROM disc that mixes audio and the graphics/text. Stores audio and graphics in adjacent areas, providing a smoother display.
Compact Disc plus Graphics	CD+G	(a technology)	An audio compact disc produced with limited graphics to complement the music. Will play in a regular audio compact disc player, without displaying the graphics. To view graphics requires a special CD+G player or another player that can read both the audio and the graphics, such as CD-I and CDTV players.
Photographic Compact Disc	Photo CD	Kodak	Compact disc technology to store photographic images. The customer's pictures, developed and placed on a compact disc, can be played through a special Photo CD or compatible player, such as CD-I or CD-ROM XA and displayed on a television set.

Continued

Product	Abbreviation	Responsible Manufacturer	Application
Compact Disc plus Musical Instrument Digital Interface	CD + MIDI	(a technology)	Music discs that play in standard CD audio players can add accompanying musical input if the player is MIDI-compatible.

Sony Data Discman	None	Sony	Portable compact disc player that uses a miniature CD-ROM disc. Designed to play interactive books or to serve as a portable reference guide. Player is lightweight and has a small pop-up screen.
Write Once-Read Many	WORM	(a technology)	Special technology that can record (but not erase) a compact disc. Application is for user with a lot of information to store and needing only a few copies of it. For example, a school system might decide to use WORM technology to preserve all its past student records. Most compact disc technologies are "read-only."
Rewritable compact discs	None	(a technology)	Computer drives that allow user to write, erase and rewrite on a compact disc. Drives combine the technique used to save information on a hard drive (magnetic) and the technique used to store information on a CD-ROM (optical). Often referred to as *magneto-optical drives*. Most common uses of rewritable drives are for backup of hard drives, storage of very large files (such as graphics), or portability of files.

Chapter 4
VIDEODISC TECHNOLOGY

Technology Quick Look

Videodiscs, more accurately called "laserdiscs," are:

- 12-inch-diameter data storage media
- An application of optical technology
- Read by laser beam and therefore very durable
- An almost instantaneous means to access full-motion video and sound

History

Laserdisc, one of the optical media technologies, was a major competitor with videotape to become the consumer video media standard. Video camera recorders (VCR) won the competition and are now in the majority of American homes. VCRs have the advantages of allowing consumers to record television programs and to play back video camera tapes.

Laserdiscs, with the advantages of quick and accurate access to the large volume of stored data, lost the consumer niche but won acceptance by training professionals in industry and government. Laserdisc became a useful component of multimedia training systems, delivering excellent visual and audio outputs. The ability to deliver video output led to the popular use of the term "videodisc" instead of laserdisc. The terms videodisc and laserdisc are interchangeable in this handbook.

Terminology

Although videodisc and laserdisc terms are used interchangeably, the term "interactive videodisc," or IVD, normally refers to those videodisc programs that have a high degree of interactivity between student and the videodisc program. This level of interactivity is referred to as Level III. Section A describes interactivity levels.

In This Chapter You will find information on interactive videodisc technology in these sections of this chapter:

Section A

Applications to Education and Training

Applications In the Schoolhouse

Videodisc systems are being successfully used in instructional programs in these capacities:

- Interactive tutorials
- Instructional games
- Simulations
- Visual and multimedia databases
- Linear documentary presentations

These applications are described in the following table.

Application	Instructional Value
Interactive Tutorials	IVD programs are designed with a tutorial strategy wherein new information is introduced and questions or other interactions are included. With IVD's ability to branch easily to any segment on the disc, a student is not locked into a particular sequence. This strategy has been extremely effective. Studies show that IVD tutorials provide a higher mastery rate and retention level than traditional classroom instruction (Fletcher, 1990).
Instructional Games	Instructors know the challenge of maintaining the interest of a generation of students who have grown up with video arcade games and the MTV channel on television. Educational games usually offer a variety of special effects and motivate students with the challenge of solving a mystery or beating the clock or the computer.
Simulations	Simulation programs can be used for problem-solving scenarios or role playing. In some cases, a procedure such as an engine replacement or a chemistry experiment may be simulated because it is too dangerous or expensive for the student to experience in person. In other cases, the student may make decisions and view the results of the decision enacted.

Application	Instructional Value
Visual and Multimedia Databases	A visual or multimedia database is a videodisc made up primarily of individual pictures, video clips, sounds, maps, technical drawings, and text. These applications are not designed to teach¾at least not in the customary tutorial fashion. Instead, they offer a wide array of interrelated information available to assist the instructor. Because there can be up to 54,000 frames on a videodisc, visual databases can offer access to an enormous amount of visual material.

Linear Documentary Presentations	Videodiscs can easily replace 16mm film libraries, at a fraction of the cost, without worries about sprocket holes and rewinding. Videodiscs do not wear out or degenerate with repeated use. In addition, many educational films, documentaries, even commercial movies are available on videodisc at lower prices than on videotapes. Also, by using the SEARCH option, any location on the disc can be accessed almost instantly.

Levels of Interactivity

Interactive videodisc systems are usually categorized into levels: I, II, III, and IV. The levels are now standards in education and training. The following table shows the differences in the levels.

IVD Interactivity Levels

Level	Interaction with Student	Equipment Required	Notes
I	Student's control similar to that of VCR user	Monitor, video player, videodisc, optional remote or barcode controller.	Player has no memory or processing power. Used mostly for entertainment applications.
II	Increased interactivity	Monitor, videodisc player with built-in programmable memory, videodisc which includes a controlling program.	Increased flexibility over Level I. Offers simple branching: player stops on multiple choice questions, student makes choice, player goes to specific frame for feedback. Problems: program will not operate on all IVD players, control program on disc cannot be changed.
III	Flexible, sophisticated interaction	Computer, videodisc player, monitor, related peripherals.	Videodisc player is essentially a computer peripheral. Student can access a term, image or video. Level III also uses computer to note and store student performance.
IV	Flexible, sophisticated interaction	Computer, videodisc player, monitor. (Videodisc can store digital data as well as analog video and sound.)	Computer-videodisc system in which videodisc is used to store digital data as well as analog. Thus the videodisc player serves as an added optical storage device to the computer.

Section B

Videodisc Technology

How Videodiscs Work

Videodiscs are a product of optical media technology, which is linked with development of the laser (**l**ight **a**mplification by **s**timulated **e**mission of **r**adiation). Both technologies are necessary to effective creation and use of the videodisc as a data storage medium.

Storing Data on a Videodisc

The mastering process to create a videodisc begins with the digital information from the master data triggering a laser to expose spots on a thin photographic film coating on a rotating glass plate. The laser can be turned on and off millions of times per second, and this pattern corresponds to the on/off value of the digital bits of data. The exposed spots are acid-etched onto the glass master disc. This is used to make a metal master disc which is subsequently used to impart the pattern onto heated plastic discs. The process is completed with addition of a reflective surface (to assist the reading of the pattern) and a plastic coating for protection of the disc. The result is a laserdisc capable of storing 54,000 frames, about 30 minutes of video.

Reading Data from a Videodisc

The videodisc spins at high speed. Heads direct a laser beam onto a selected track, the reflected light is converted into electronic signal and used to format the data for the output device. The output can be video, sound, still image, text or data.

Still Frame and Motion Video

Frames are stored on concentric circles on the videodisc. The player can display the same frame as long as the user wants. Users can access each of the 54,000 frames on each side of a disc. If motion is wanted, frames are played at a rate of 30 frames per second and the user views it as full-motion video. The user can step forward or backward a frame at a time, or can scan forward or in reverse at various speeds. The result is that instructors using a videodisc system have flexibility in the use of an enormous data base.

Two Videodisc Formats

There are two videodisc formats and most recently-manufactured players can play videodiscs of both formats. The format discussed so far, with 54,000 frames, is called CAV for **constant angular velocity**. This format, because of its versatility, is the one most used in education.

The second format is called CLV for **constant linear velocity**. On CLV, the frames are stored on a spiral pattern with several frames or parts of frames on one revolution. This allows more data on the disc, up to 60 minutes of motion per disc side. The drawback is that CLV cannot still-frame and step through its data. Most CLV discs are used for movies or other linear applications, from beginning to end. Items on the CLV-formatted disc are found in time increments, e.g., 4:56 for 4 minutes and 56 seconds into the disc as measured from the beginning.

Comparison of CAV and CLV Formats

The features of the two videodisc formats are compared in the following table.

Feature	CAV	CLV
Minutes per Slide	30	60
Normal Play	Yes	Yes
Still Frame	Yes	No
Step Frame	Yes	No
Multiple Speed	Yes	No
Scan	Yes	Yes
Frame Search	Yes	No
Time Search	No	Yes
Chapter Search	Yes	Yes

Audio Tracks on Videodiscs

Two audio tracks are available on all videodiscs. Flexibility in use of the tracks individually or simultaneously can produce stereo music, and can present narrations in two languages, or a narration for students and a narration for instructors, or narrations designed for different student levels.

One limitation of audio on laserdisc is that audio will be produced only if the videodisc is playing forward at the standard 30 frames per second. There will be no sound at other speeds or in reverse.

Section C
Videodisc Advantages and Disadvantages

Impact of Videodisc Systems

Videodisc systems have widespread use in military education and training. Although not the best media selection for all applications, videodisc is often a most capable choice. The following charts summarizes the advantages and disadvantages of videodisc systems.

Advantage	Impact
Access	Fast and precise. Frames and segments can be identified for presentation through use of a computer, a remote control, or a barcode reader.
Cost of Programs	Many commercially-available videodisc programs are less expensive than those on videotape or film. (Range: $50-700)

Durability	Images on the disc do not degenerate with use. After years of use, the video will look as clean and sharp as it did the first time.
Quality	Videodiscs are generally recorded with 350 lines of resolution. VHS and Beta videotapes are recorded with only 200 to 250 lines of resolution. Videodiscs have a sharper appearance and better-quality picture.
Storage	Videodiscs are easy to store, take very little shelf space and will not warp.
Interactivity	Unlike videotape or film, it is relatively easy to control a videodisc with a computer. Level III videodisc programs provide the interactivity and instant feedback of computer-assisted instruction with visual and audio realism.
Still frame	Still frames can be halted for hours with no damage. This provides individual access to every frame on the disc.
Dual audio tracks	The two audio tracks on all videodiscs can be creatively used for applications such as bilingual narrations or stereo sound.
Format standards	Although there are two different video formats (CLV and CAV), all videodisc players can play all laser standard videodiscs.
Great utility	Instructors can use videodisc programs developed, can program them for individual or group use, and can select segments for classroom audiovisual aids. Videodiscs also serve as research and reference databases.

Disadvantage	**Impact**
Cost of Programs	Front-end design and development costs for quality programs can be expensive.
Cost of Hardware	Players that interface with computers and provide remote control units currently cost about $700. However, the cost of videodisc players continues to decline.
Maintenance Costs	As with all equipment, an annual maintenance budget is part of life cycle costs.
Lack of Interface Standards	Connecting a computer to a videodisc player can be very frustrating. Different players require different interface cables and speak different "languages." Software programs must contain appropriate drivers, and baud rates have to be set correctly.
Read Only	Videodiscs are read-only; the user cannot record on the disc. This is a disadvantage in that student productions or other creations cannot be recorded or copied.
Difficult for Group Instruction	Without expensive video projection equipment, a video display is limited to the video monitor size. Level III delivery with two monitors also has the problem of projecting the computer screen for group instruction.

Computer Storage Requirements	If a Level III videodisc program is to be used, computer software will be needed to run the program. In some cases, the amount of storage space required on a hard drive approaches 10 megabytes.
Lack of Computer Compatibility	Before a Level III program is purchased, check carefully to determine which computer family it requires. As with other software programs, if it is written for the Macintosh, it will not run on an IBM, and vice versa.
Limited Motion Sequences	Up to 54,000 still frames is a tremendous capacity for videodisc, but when this is translated into motion sequences, the limit is 30 minutes, much less than a videotape's capacity.
Lack of Instructional Materials	To date, there is a scarcity of instructional materials to support the use of videodisc programs. In many cases, instructors are left to personal initiative and creativity to integrate the programs into the curriculum.

Chapter 5
DIGITAL AUDIO

Technology Quick-Look

Digital audio is now a standard of multimedia systems. The addition of sound to the visual media capabilities of the computer-based systems is possible because:

· Technological progress in analog-to-digital converters (ADC) and digital-to-analog converters (DAC) has made digital audio possible.

· Audio recorded as numeric values allows digital computers to capture, manipulate, store, and distribute sound.

· Significant advantages of the digital audio system are:

- Quality of sound is maintained.
- Control of the audio media is now possible as an integral medium of the computer-based multimedia system.

History

Until the 19th century, sound could be manipulated only physically. More instruments, larger instruments, improved design of concert halls were examples of attempts to enhance sound. By the late 1800s, several inventors were trying to convert sound waves to electronic sound. Their primary goal was to amplify the sound, but success also led to the ability to store, manipulate, copy and retrieve the sound for later presentation.

In nature, sound, light and electromagnetic waves are analog, meaning their signals occur in smooth variations. Because electricity is also analog, early electronics were also based in analog. Modern electronics are digital, representing values as numbers and in separate, discrete steps (as contrasted with analog's smooth, flowing waveforms).

Today's multimedia electronics offer significant potential for education and training. The instructor's ability to access and store tremendous amounts of information and selectively develop them into knowledge transfer systems and courses and present them to students in clear, convenient, even motivating, ways represents significant progress in the development of education and training.

In This Chapter

You will find information about digital audio technology in these sections of this chapter:

Section A
Applications to Education and Training

Introduction

Digital audio adds the true sound dimension to multimedia in its many and varied uses for educators and trainers. Potential uses are essentially limited only by the creativity of the instructor and course designer. Examples of applications and capabilities of digital audio are:

- Computer control
- Sound-critical subject areas
- Recording student inputs
- Computer presentations in classroom
- Repurposing videodisc programs
- Speech therapy
- Music

Computer Control

With digitized sound, a computer treats a sound file just as it does a text file. Editing sound files is similar to editing in word processing programs. Precise control of quality sound to be delivered as part of multimedia programs gives the CBT course designer and the classroom instructor great flexibility in making instruction effective.

Sound-Critical Subject Areas

Most education and training programs that cover subjects in which sound is critical are enhanced by the use of digital audio. Some examples are:

- Language training, including pronunciation drills by students.
- Diagnosing mechanical operations by the sounds produced, such as jet engine runs and motor vehicle tuning.
- Providing audible feedback to student inputs, such as simulated radio transmissions to aircrew members rehearsing missions.

Recording Student Inputs

Instructors and students can record their own voices or sound inputs on the computer system, storing them for future reference or for providing immediate feedback or practice. With proper CBT program design, students' aural inputs can be stored for instructor monitoring and even end-of-course comparison.

Computer Presentations in the Classroom

Computer-controlled presentations, in the classroom or other audience environment, now include audio as well as visual elements. The computer system becomes a versatile presentation tool for the instructor, replacing other less reliable and unsynchronized systems.

Repurposing Videodisc Programs

Programs repurposing videodiscs present a problem in that the audio on the disc is tied to the video and cannot be changed. By implementing digital audio, instructors can use existing video segments and add to customized audio to correspond with lesson objectives. Digital audio can also be used in conjunction with still frames of a videodisc.

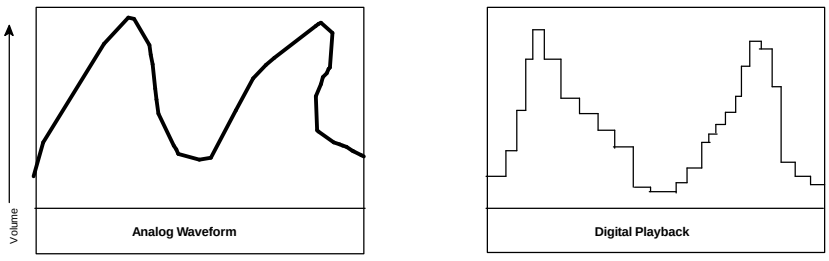
Speech Therapy Programs can be used by speech and language therapists to help people with speech impairments. Speech therapy programs digitize and analyze verbal characteristics such as pitch, loudness, and intonation. They also provide exercises on pronunciation, pitch, and speech timing.

Music Digital audio capability on computers has quickly become an important means of creating and teaching music. Several academic and commercial programs are available that focus on music. They provide notation and composition, drill and practice programs, and instruction in differentiating rhythm patterns, pitches, and triads. Major advancements made possible by musical representation standards are covered in the MIDI section that follows under technology.

Section B
The Technology

The Basics Sound, which occurs naturally as an analog waveform, can be converted to digital signals and recorded and stored as a file on a computer's hard disk or on a compact disc. The file is controlled by the computer program. It can be edited and otherwise manipulated, and accessed for near-instantaneous output. The output is converted from digital signals back to analog signals and played through output devices, usually speakers.

How Audio is Digitized Sound is digitized through a sampling process. At small, discrete time intervals, the computer takes a sample or reading of the waveform. The number of samples taken within a second is the "sampling rate." The result is a digital, stairstep-looking representation of sound, as contrasted with the smooth-flow analog waveform. See Figure 2.



Audio Quality

The higher the sampling rate, the better the quality of the sound. Note, however, that sampling higher rates, and thus quality, requires greater use of storage. The controlling factor should be the quality of sound needed to meet the objectives of the education or training.

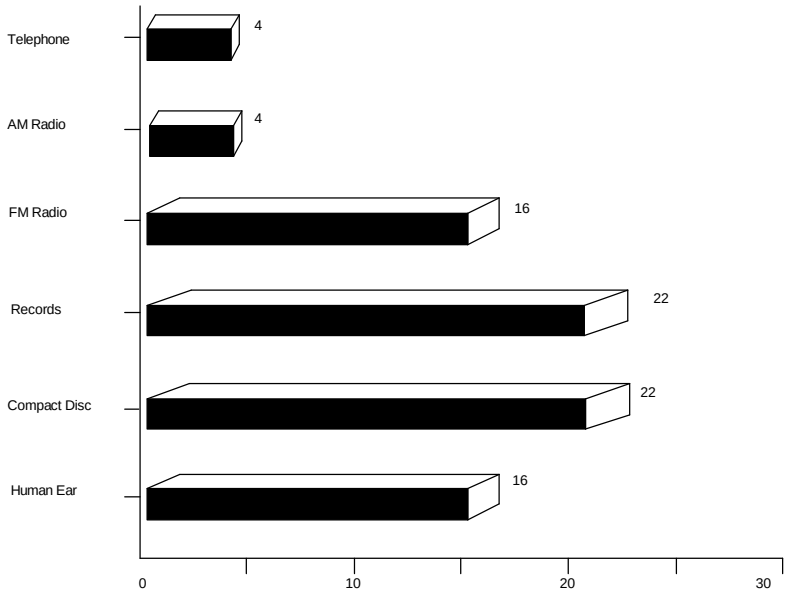
Your ear can be as good a judge of audio quality as the complex specifications of the audio system. If audio is a critical component of the system, find an opportunity to listen to comparable systems under consideration.

Human Hearing

The hearing range of most humans is approximately 20 hertz to 17 kilohertz. A hertz, abbreviated "Hz," is a unit of frequency equal to one cycle per second; a kilo-hertz is 1,000 hertz.

Examples of Frequency Ranges

Figure 3 shows the frequency ranges of the human ear and some media. The sampling rate should be twice the highest frequency required. Thus, if a 4 kHz frequency is desired for a voice application, the sampling rate should be 8 kHz or higher.



Music

Music is generally higher-quality sound. Higher sampling rates are recommended: at least 11 or 12 kHz and preferably up to 22 kHz.

Disc Storage Requirements

Decisions about the quality of digital sound also relate to available storage space. The following table illustrates the tradeoff between sampling rates and storage requirements.

Storage Requirements for Various Sampling Rates

Sampling Rate	Recommended for	Storage for 1 second of sound	Seconds of sound per 1MB storage
22 kHz	Music quality	22 Kilobytes	45 seconds
11 kHz	Other quality	11 Kilobytes	90 seconds
7 kHz	Voice narration	7 Kilobytes	135 seconds
5 kHz	Minimum for voice	5 Kilobytes	180 seconds

Hardware and Software Considerations Consider these hardware and software issues related to digital audio in a CBT multimedia system:

Hardware/Software Considerations	IBM and Compatible PCs	Macintosh Computers
Audio Recording Requirements	Requires that an audio card be installed or an external audio peripheral be added. Peripheral attaches to computer's serial port, can be moved for use on other computers.	Latest models include required board and software and microphone. Other models require an external sound digitizer. MacRecorder is popular peripheral.
Audio Playback Requirements	Playback uses same audio card or peripheral. Other playback machines must have cards/peripherals compatible with recording machine.	Playback is through built-in digital-to-analog converter.
File compression	Optional on many audio cards. Compression of files saves storage but may degrade audio quality.	Requires additional software programs.
Speakers	Required for output. Most are externally added to system.	Built-in on most models.
Microphones	Can come built-in or be externally connected.	Most models have built-in mikes. MacRecorder includes built-in microphone.

Additional Considerations for Music

In 1983, a group of electronic musical manufacturers developed an international standard protocol for electronic music devices. Called MIDI (pronounced "mid-ee"), the Musical Instrument Digital Interface allows musical instruments, such as electronic keyboards, to be connected to computers. MIDI is not digital audio.

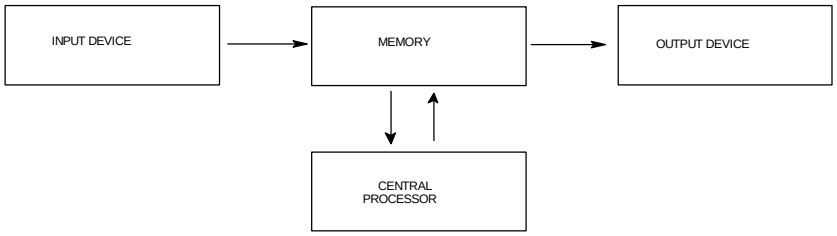


Figure 1 A MIDI Configuration with a Macintosh computer

The configuration for MIDI includes the computer, a MIDI interface box, and a MIDI instrument, such as a keyboard. Available software, compatible with IBM-compatible and Macintosh systems, allows the user to compose, edit and record music. Commercial MIDI files are also available.

Section C
Advantages and Disadvantages of Digital Audio

Impact of Digital Audio Features

Digital audio offers many features for computer-controlled sounds, but there are limitations to be considered. The following tables highlight the considerations.

Advantages	Impact
Random access	Digital audio enables audio to be retrieved and played instantly (on the order of milliseconds). In most systems, to access the audio, the user simply enters a "Play" command followed by the name of the file.
Ease of editing	Audio files are stored with a file name, just like other computer files. Audio files can be deleted or replaced simply by using file command utilities. Tools enable users to cut and paste sounds to edit narration. The process is as easy as using a word processor.

Cost	Moderate-cost, good-quality digital audio computer cards for MS-DOS computers are widely available. Newer Macintosh computers have built-in audio record and play capabilities.
Flexibility	Digital audio (as opposed to audio on a videodisc) is not tied to a particular video segment. Therefore, digital audio can be played in conjunction with any segment on a videodisc, if desired.
Limited only by storage space	Analog audio on a videodisc is limited to 60 minutes per side. There is no limit to the amount of digital audio, other than that imposed by the amount of storage space available.

Disadvantages	Impact
Large storage requirements	Audio files require a large amount of disk storage space; one megabyte for 180 seconds of sound sampled at 5 kHz; one megabyte for 45 seconds sampled at 22 kHz.
Large memory requirements	Although a Macintosh with one megabyte of RAM can be used to digitize and play audio, the results will be limited. Audio files must often be loaded into RAM first, before playing. A large RAM is essential, or the files will be limited to a few words each.
Lack of standardization of hardware	There is a distinct lack of standardization of file formats for digitizing audio (especially for MS-DOS machines). Audio files digitized with one type of audio board usually cannot be played back unless the same type of board is in the delivery hardware.
Difficult to synchronize	Because audio files are usually loaded into RAM before they are heard, the amount of time needed to play a file fluctuates according to file size. This variation makes it very difficult to coordinate the audio with motion video.

Chapter 6
DIGITAL IMAGES AND VIDEO

Technology Quick-Look

Graphics, images, and video presentations are important parts of multimedia computer programs. Growing demand for interactivity and for the means to manipulate the data are spurring progress in the digital capture and storage of the data. A quick look at the capabilities follows:

- Capture devices are readily available to digitize inputs:
  - Scanners for print copies of text and graphics, photographs, slides, and other still images.
  - Video digitizers and software to convert analog motion image inputs from videotape, digital cameras, video cameras, and broadcast television.
- Data manipulation and editing devices and software programs are readily available for many specialized applications and processes.
- Computers can store, copy, and distribute image data without degradation of the data. Every image is as clear as the first. Data converted into images can be output:
  - Directly to the computer screen for inclusion in multimedia programs.
  - Through other playback devices such as television monitors, printers, or to networks.

History

Early efforts to include graphics in computer programs required the talents of professional graphic artists and computer programmers. Results were costly and limited. Photographic representations were not possible.

The development of digitizing technologies, many similar to those involved in the digitization of audio, has made possible the incorporation of still and even motion images of all varieties. These successes are at the foundation of the multimedia programs that are extensively used today in education and training arenas.

In This Chapter You will find information about digital images and video in these sections of this chapter:

Section A
Applications to Education and Training

The Visual Element

Educators and trainers have long used visual aids to enhance their teaching of students. From printed texts to printed photographic materials to slide shows, films and video, the visual element has been common to transfer of knowledge.

Education's slow adoption of the computer to academic and training tasks has been paced by the computer's developing capability to include more visual elements on a screen. Though the development will never be complete, the computer industry's ability to digitize visual materials is accelerating educational use of computer systems.

Improved Applications

The following educational and training applications of computer technology have benefited from digital image and digital video advancements:

· Multimedia courses. The compelling aspect of multimedia, the ability to rapid- access a wealth of stored information, now includes effective visual information.

· Development process required for classroom courses, illustrated materials, aids.

· Research of and input from reference and resource visual databases.

· Publishing of illustrated products for student and other uses, including sophisticated copies of student-produced products.

· Exporting, networking and other distributive sharing of courses to other student sites.

Section B
The Technology: Digital Still Images

Introduction

Still images (single images, as opposed to a series of images that appear to have motion) are a mainstay of visual information systems used in education and training. Still images include photographs, drawings, charts and other graphics normally found in print form or film.

Still-Image Basics

Computer systems work with digital information. The capture and conversion of images from analog to digital form is the necessary first step. Once digitized, the data can be creatively edited or manipulated or combined, then stored, and then output in a means useful to the educator or trainer.

Capturing Still Images

The most efficient way to capture still images is with a graphics scanner, a computer peripheral designed to convert print materials into digital data. The scanner works much like a photocopy machine, except that its output is not a paper copy but an image transfered to a computer screen. Once on the screen, the image data can be changed, output to other devices, or stored in the computer memory.

How a Scanner Works

Most scanners are "flatbed scanners." As in photocopying, the graphic is placed on the glass surface, a light is passed under it, and the resulting signals are readable by a computer.

When images or text materials are scanned, the computer sees a collection of dots. The dot is normally called a "pixel." Each pixel can be changed in color, brightness, location, and size. This control of the elements of what the user sees as an image is the greatest advantage offered by the digitization of visuals.

Scanning Slides

Many flatbed scanners offer optional devices for digitizing slides. Specialized slide scanners offer better control and resolution of the image. As with all scanning processes, the quality required by the eventual use of the image is the major factor driving the level of resolution.

Scanning Text

Scanning text into a computer requires the addition of optical character recognition (OCR) software. High-end or specialized scanners often include the software. Until the OCR is added, the computer sees scanned text as pixels, just dark or light dots, not as letters or numbers. Many OCR packages are available; the user pays a price for accuracy and flexibility.

Managers must weigh the cost of the OCR-capable scanner with the time saved by not having to re-key the text into the computer.

Scanner Equipment

Scanners come in many shapes and sizes, from a $40 hand-held model to a multi-thousand-dollar, high-resolution, color-capable model with OCR software. Macintosh computers are usable with direct cabling to the scanner. IBM and compatible computers usually require installing an additional card in the computer, then cabling the scanner to the computer. The software required to read the scanned image normally comes with the scanner equipment.

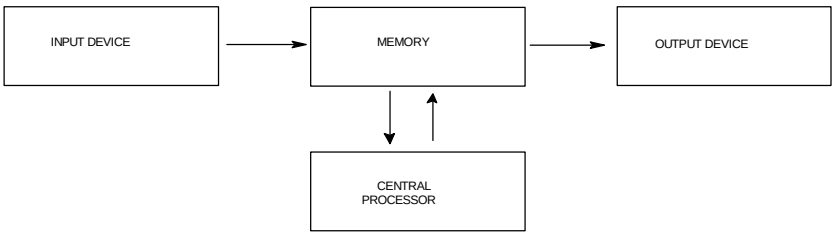


Figure 2Figure 5. Equipment Configuration for Scanning

Frame Grabbers

"Frame grabbing" is a useful technique to capture a still photo or one frame of video motion, digitize it and save it on the computer. The input signal goes through the digitizing card and is played in a window on the computer screen. When the wanted frame appears, a keyed command grabs and files it. From this point, the image is a still image and can be worked accordingly.

Image Resolution

The resolution or clarity level of the image to be scanned into the computer should be based on the eventual use of the image. For example, if it will become a product to be printed on a laser printer, a resolution of 300 dots-per-inch would be appropriate. However, if the image will remain a computer product, a resolution of 72 dots-per-inch would work. Scanning at higher resolution rates impacts disk storage space.

Memory and Storage Requirements

Scanners require large amounts of random access memory (RAM) to capture images and much storage space to store them (up to a megabyte for some images). These requirements dictate reasonable planning on the number and resolution of images to be scanned. The recommended technique is to scan only the area of the graphic wanted, preview it on the computer screen and make adjustments before saving it to the computer storage.

Section C
The Technology: Digital Video

Clarification of Terms: Video and Television

Distinguishing between television and video can be a lesson in futility. The technologies are inseparable, and what happens in television impacts the field of video. The following perspective of the two may be useful:

· Television has to do with the broadcast or cable system delivery of someone else's programming on a timetable determined by someone else.

· Video has to do with the ability to record, edit and play back programming on the user's schedule.

Similarities to Digital Still Images

As with still images discussed in Section B, the digitizing of video images represents a major advancement in computer technology, an advancement of great use to educators and trainers. The capture and use of video images requires converting analog signals to digital data. A review of analog and digital issues, as they relate to video, will be useful at this point.

Analog versus Digital

Analog video systems have been successful since their development in the 1930s. There was little consideration to converting television and the supporting video technologies from analog to digital formats as long as the digital technology did not offer economic and other outweighing advantages. Many experts see the current period as the transition period in which the transformation is taking place. The following table contrasts some of the important aspects of analog and digital systems applied to video.

CONTRASTING VIDEO TECHNOLOGIES

Analog	Digital

Materials are in continuous form. Data is in waveform, cycling and flowing. Most of nature is analog-like.	Views everything in discrete individual values.
Represents materials as continuous electrical signals.	Represents analog materials by sampling, recording precise values at each sampled point, and presenting the series of data points as very close approximations of the natural images.

Analog	**Digital**
Analog data can have any degree of brightness, and infinite numbers of colors, shades, values.	Digital data are precise values, each represented by a combination of on/off electrical impulses. An example of a limitation: VGA boards are limited to 256 specific number of colors.
Television was designed as an analog medium to reproduce and broadcast natural images. TV cameras convert images to continuous electrical signals. TV monitors deliver images by varying the intensity of light beams on the screen, giving the illusions of motion and unlimited colors.	Digitizing video has become possible as technology has developed ADC and DAC converters, large storage capacities in magnetic and optical disc media.

How Video is Digitized

To digitize video from a camcorder, videotape, videodisc, or broadcast television, the input signal must be processed through a digitizing card added to the computer, or through a peripheral. This converts the analog video signals into digital bits of information for each pixel (picture element) of the computer screen. The software that comes with the digitization cards controls the process. Video images can be filed from the screen to the hard disk (which requires a large storage space) or can be output for playback or transmission to other devices, such as a printer.

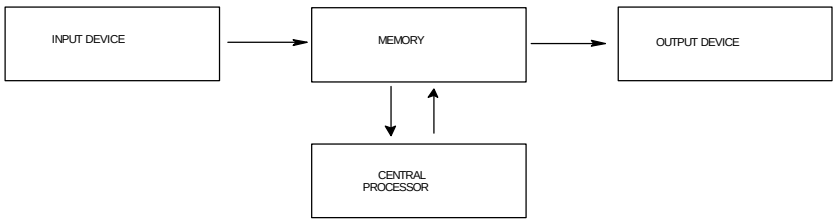


Figure 3Figure 6. Equipment Configuration for Digitizing Video

Difficulties in Digitizing Video

The difficulties still challenging the industry in the digitization of video are in these areas:

· Acceptable range of colors and shades. Limited variations in colors and shades makes digital images appear not to blend well. Some images appear to have sharp, striped edges.

· Sufficient memory and storage capability. Digital images (and sound) require large amounts of memory for processing and storage of digital data. The current compromise of recording data at lower quality levels is not always satisfactory.

· Data transfer rates. Large digital files are difficult to display on the computer screen at the standard 30-frames-per-second rate, the accepted "full-motion" rate.

The Impetus for Digitizing Video

The industry is committed to overcoming the difficulties for these reasons:

· Error-free format. Digital systems, based on few, discrete values (usually 1 and 0), can reproduce and transmit data error-free.

· Potential for interactivity. Digital systems, incorporating the excellent control capabilities of the computer, provide more intricate branching and integration possibilities. The result is systems that are largely individually tailored. The user is given a degree of control.

· Ease of manipulation. Digital data can be resized, recolored, repositioned, and duplicated with relative ease and without the high costs of analog video editing equipment.

· Durability. Digital data can be reproduced without any loss of quality. No "noise" is introduced into copies ("snow" in video or "hiss" in audio). This is important to transmitting data over a network, such as in networked classrooms at the Air Force Academy and local area networks at training facilities or between them and students across the base.

Interactivity Compared to Videodisc

The control possible with digital media exceeds the interactivity of the videodisc (also known as interactive video). The videodisc is analog and its user can only access, not change, what the designer put on the disc. With digital media, users can control and change the content, sequence, and transitions.

Current Status and Near- Term Changes

Air Force education and training managers must note that the television broadcasting industry is converting to High Definition Television (HDTV) and digital format. At the time of this writing (late 1993), the recently concluded National Association of Broadcasters annual meeting ended with experts and government officials stating: Make the transition to digital. (Multimedia & Videodisc Monitor, June 1993)

The Federal Communications Commission (FCC) has been testing competing HDTV systems proposed by industry teams. The four competitors have agreed to form an alliance, essentially merging aspects of all proposals. The FCC has told all broadcast operations to have some HDTV broadcast capability by the year 2000. The full transition is forecast by 2010.

Impact of the Standards

Video technology essentially follows television technology. The developing standards will focus emerging digital video technologies. The impact on education and training is a natural follow-on. Note to managers: keep the national-level industry dealings in mind for decision making that has impacts 5 to 15 years out.

Section D
Current Digital Video Applications

Motion Video-in-a-Window

The size of a digital video file on a computer's hard disk may prevent it from being played in full motion, 30-frames-per-second rate. There is a technique for displaying full motion video without saving it to the drive. Known as "video-in-a-window," the technique uses a real-time video display card to digitize and display motion video at the full-motion rate, directly from the analog source. Video-in-a-window does not save the video.

Reviewing Commercial Digital Video Products

Many major hardware and software companies in the computer and video and broadcast industries have marketed digital video applications. The technologies and systems, and some of the products, are useful to educators and trainers. The table is a guide to capabilities and limitations. Managers should note that the computer products marketplace and development labs remain very dynamic. The specifics in this table are only guides and reflect information current at publication date.

	Videodisc	QuickTime	Digital Video Interactive	Compact Disc - Interactive	Commodore Dynamic Total Vision	Visual Information System
Manufacturer	Various Companies	Apple	Intel/IBM	Philips	Commodore	Tandy
Analog/Digital	Analog	Digital	Digital	Digital	Digital	Digital
Primary Hardware Platform	Apple IBM Macintosh	Macintosh	IBM Macintosh	Integrated Player	Integrated Player	Integrated Player
System Description	Laser videodisc playback system. Added computer provides sophisticated access and degree of interactivity	To compress and play digitized video movies, including educational titles and encyclopedia references. Editing of video clips.	Technique to digitize and compress video. DVI board decompresses for max 72-minute full-motion, full-screen video.	Integrated player of digital video. Combination of CD-ROM player and built-in computer to connect to home TV. Consumer market, entertainment.	Multimedia player for output to a TV.	Multimedia player for output to TV. Includes limited storage. Dual remotes allow game playing.
Maximum Size of Video Window	Full Screen	1/4 Screen	Full Screen	Full Screen	1/4 Screen	1/4 Screen

	Videodisc	QuickTime	Digital Video Interactive	Compact Disc - Interactive	Commodore Dynamic Total Vision	Visual Information System

Minimum System Requirements	Level III interactivity: · Videodisc player · Computer · Video monitor · Selected peripherals	· · · ·	Digitizing board for captur[illegible] Color Macintosh computer and monitor. Apple System 6.07 or above 2 to 4 MB RAM. Large hard drive or CD-ROM.	High-end IBM, compatible, [illegible] Computer monitor. DVI computer board set. Input device.	CD-I control unit with built-in CD-ROM player. CD-I compact disc. TV receiver or monitor. Input device.	CDTV CD-ROM player with built-in CD-RO[illegible] CDTV compact disc. TV receiver or monitor. CDTV keypad or remote mouse for inpu[illegible] · [illegible] disc · TV receiver or monitor · Remote controller
Advantages	· Interactivity: fast, precise data access and control at Level III. · Cost: relatively inexpensive for interactive system (about $700 for player), program titles same or less than video or film. · Flexibility: capable of 54,000 still images per disc side, or 30 minutes of full-screen, full-motion video with sound. · Support for education: system and peripherals designed for educational and training uses.	· · · ·	Inexpensive No additional delivery hardware. Synchronizes video and audio. Flexibility to share programs with other Macintosh applications.	Ability to integrate media. Capacity: 72 minutes of full-motion, full-screen video [illegible] Generic equipment works with IBM-compatible [illegible] Compatibility: [illegible]	Cost: consumer model is under $1,000, [illegible] Uncomplicated interface: connects to TV like a VCR. Ease of use: insert disk, turn unit on. Capability: a commercial model [illegible] $700 [illegible] CD-I has connections for peripherals like keyboard.	Cost: [illegible] most programs $[illegible] Uncomplicated interface: connects to T[illegible] Expandability: peripherals can be added, [illegible] · Uncomplicated interface: connects to TV like a VCR. · Compati-bility with other software: Windows compati-bility makes system easy to develop for and facilitates transfer of existing programs.

Continued

	Videodisc	QuickTime	Digital Video Interactive	Compact Disc - Interactive	Commodore Dynamic Total Vision	Visual Information System
Disadvantages	· Cost: program development costs are high. · Interface standards: lack of early standards require checking compatibility of player, computer, software. · Read-only: user cannot record on disc.	·	Small picture. Requires large RAM (2 MB minimum). Playback at less than 30 frames per second.	Hardware costs: development and delivery machines required. Few educational programs currently available.		

Chapter 7
MEDIA INTEGRATION TECHNOLOGY

Introduction

All multimedia productions require a software program to tie together and control the various media which can be called into the presentation. Media integration package is the general term for these software programs. Development of media integration programs is a continuing thrust, because progress in this and related fields facilitates the development and delivery of multimedia computer-based programs of value to education and training.

Terminology and Categories

These broad categorizations help the novice's understanding of software development:

· Media integration packages. As noted in the introduction, this is the umbrella term for software programs that pull together the many media elements and control the flow of the product.

· Presentation software. These programs are usually entry-level software for creating the traditional slide show.

· Multimedia production software. These programs pull together the several media (text, graphics, sound, animation, video [even smell is now possible]) programs and synchronize their working together.

· Authoring systems. This category refers to software programs used to prepare productions. It includes software that accesses databases and controls calling external information into the system for incorporation into the new production.

Blurring of Categories

Note, however, that the lines between these categories are rapidly blurring. The thrust in software development is to simplify the production requirements of the user. In education and training, the thrust should lead to simplified development of courses and materials and to more flexibility for instructors.

In This Chapter

You will find information about media integration technologies in these sections:

Section A

Progress in Integration Software

An Assumed Limitation

The software development environment is and will always be too dynamic to allow a one-time, comprehensive summation. The following areas have been chosen to give managers a sense of some of the activities and trends that are underway. These areas have been chosen because of their relevance and utility to the many people and levels of education and training in the Air Force.

- Internal tools
- Clip media
- Timing and synchronization
- Database support
- Cross-platform compatibility

Internal Tools

The software "tools" used to create and edit media programs are often included in the package. Generally, the internal tool set that comes with program will satisfy the user's need to accomplish the intended purpose. However, more extensive tools in the form of other specific application software are almost always available. More experienced developers may prefer the added sophistication. The trend today is to bundle significant tool programs with the creation/editing package.

Clip Media

Many manufacturers of media integration packages are increasing the media libraries content of their products. The ready availability of clip art, music, stock photos, and animation makes deadline products easier to accomplish. The quick and inexpensive creation of a satisfactory product often is the better choice of more talented, sophisticated individual inputs to a product.

Timing and Synchronization

The correct timing of the input and output of a program's elements is critical to a multimedia production. It is as simple as having sound and visual in synchronization. Timing and playback are complicated by the processes used for each medium, the processing speed of the computers, the size of the digital data files, and many other factors. The solution has been developed in the form of equipment and software that establishes an absolute timing reference.

Database Support

Extensive interactive productions may include the ability to access databases. This is useful to allow the user to search for all related information in the area of interest. Those databases may be text, sound, graphic, and visual. Some interactive productions also allow the user to input additional information into the databases. These features, though adding cost to the production, can significantly enhance the educational and training effectiveness.

Cross-Platform Compatibility

This need has not been satisfied by multimedia producers. Programs created on one platform generally do not play on another. A limited number of programs are designed in versions for both Macintosh and IBM-compatibles and can be transported for play on the other platform.

Section B
Hypermedia

The Hyperlink Concept

The ability to link information to related information is the key to the thought process. Sensory perceived information has traditionally been recorded in a linear fashion, such as sequential frame after frame, and musical note after note. The human brain, however, has the ability to search knowledge and experience memories to connect directly and indirectly related information into new patterns. Humans are now teaching computer systems to perform similarly. The linking of information in this concept is called "hyperlink."

Multimedia + Hyperlink = Hypermedia

Combining the hyperlink concept with computer-based multimedia production capability has introduced the term "hypermedia."

Definition of Hypermedia

Hypermedia is a computerized non-linear system in which information elements are linked such that the user can choose alternate paths to reach all related elements of information. In a multimedia system, the information elements can be in text, sound, graphic, video, and even olfactory form.

A Hypermedia Program Example

The opening screen of a hypermedia application on the F-16 aircraft shows a graphic of the aircraft. Unseen behind the graphic are several areas, called "buttons," which allow the user to choose a part of the aircraft to investigate. If the student selects the landing gear area of the graphic, another screen appears with a close-up of the gear. Selection of the wheel hub brings up a motion clip of the disassembly of the hub, or the brakes, or the hydraulic system, or any related areas which the student chooses to pursue.

Section C
Hypermedia Applications for Educators and Trainers

Value for Educators

Educators and trainers can now apply the power of hypermedia applications to courses that enable students to choose information in the combinations and sequence that make it most comprehensible.

Examples of Applications

Hypermedia development offers the following educational and training incentives:

- Tool for database management
- Preparation for presentations
- Development of handout materials
- Design of instructional materials
- Control of multimedia devices
- Share hypermedia creations

Tool for Database Management

Many hypermedia programs were designed as databases and are excellent for storing and retrieving various formats of information. Using hypermedia, course developers and instructors can create their own database managers, such as an inventory of equipment or videodisc images.

Preparation for Presentations

Hypermedia programs are quick tools for creating impressive presentations. Electronic presentations (rather than static overheads) offer the advantages of last-minute changes, dynamic input from the audience, and special transitional effects. A projection system, connected to the computer, is needed to project for a large group.

Development of Handout Materials

Many hypermedia programs offer excellent options for creating handouts. If a hypermedia program is used as a presentation tool, copies of the screens can be printed, even printing up to 32 screens on the same sheet of paper.

Design of Instructional Materials

Hypermedia programs have revolutionized authoring systems, the computer programs designed specifically to create computer-based instruction. For example, to create a multiple-choice question with hypermedia, an invisible button is placed over each possible answer. When a student selects an incorrect answer, the student will activate the button. This brings up feedback about the incorrect answer or another chance to answer the question. When the student selects the correct answer, the button will instruct the program to go on to the next question.

Control of Multimedia Devices

Most hypermedia programs provide an easy way to control videodiscs, sounds, and CD-ROMs. Using a hypermedia program to access a variety of different media is also referred to as *multimedia.*

Shared Hypermedia Creations

Copyright and licensing restrictions often curtail the distribution of computer programs¾even those you create yourself. Most hypermedia programs, however, allow developers to distribute their programs freely, without a license agreement. This distribution freedom has resulted in the availability of many hypermedia programs through bulletin boards and shareware organizations.

DoD Guidelines on Commercial Software

DoD instruction 1322.20 requires that commercial software programs used to develop interactive courseware be delivered to the government with unlimited rights for use.

Section D
Overview of Leading Hypermedia Programs

Overview

Most hypermedia development tools are based on a screen-and-object format. Each screen can contain a variety of objects, including fields, buttons, and graphics. See Figure 7. Also, each screen has two layers, foreground and background, and each can have objects.

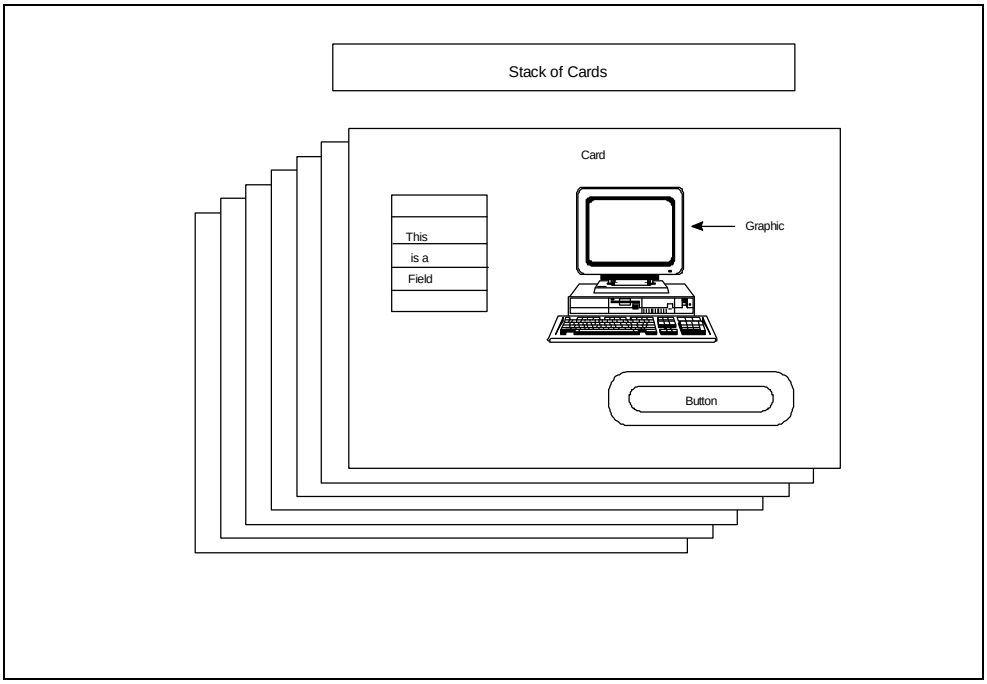


Figure 4Figure 7. A Basic Hypermedia Structure

Cards, Stacks, Fields, Buttons, and Graphics

The commonly used terms have these meanings:

- **Cards** are screens. Each screen is a card.
- **Stacks** are groups of cards, like a pile of notecards.
- **Fields** are designed to contain text and are like small word processing blocks.
- **Buttons** are designated areas of the screen that can initiate an action, such as branching to another card.
- **Graphics** are objects that can be created within the hypermedia program or imported from clip art or other programs.

Leading Hypermedia Products

A review of three of the leading commercial hypermedia software programs will be helpful to managers:

- HyperCard. Apple introduced this hypermedia development program in 1987 for its Mactintosh computers. Originally included with each Macintosh, the software is now distributed by Claris Corporation.

  Characteristics:

  - Fits on one Macintosh diskette and will run with one megabyte of RAM.
  - Assists user to design applications from databases to presentations.
  - Can control VCRs, camcorders, CD-ROM players, and other extensions.
  - Includes other Macintosh software support, including System 7 and QuickTime.

  - Cost is approximately $200.

- LinkWay Live. Distributed by IBM, LinkWay is an MS-DOS hypermedia development program.

  Characteristics:

  - Supports IBM and compatible computers.
  - Was designed for applications in education and training.
  - Includes additional programs for editing text, producing graphics, editing fonts.
  - Requires a minimum of 384K of RAM and a CGA card and mouse
  - Graphics can be created with an internal program or captured from an external program.
  - Contains a scripting language with built-in commands and functions.
  - Uses these terms: a screen is a **page** and pages in the same file make up a **folder**. Button selections include pop-up picture and pop-up text.
  - LinkWay Live uses buttons to access video and audio and supports videodisc players, audio boards, digitized video, and DVI.
  - Cost is approximately $150.

- ToolBook. Asymetrix created this do-it-yourself graphics package for multimedia applications on IBM and compatible computers.

  Characteristics:

  - Operates on the MS-DOS platform in the Microsoft Windows environment.
  - Requires minimum of 2MB of RAM and 6MB of storage.
  - Products include multimedia courseware, presentations, enhancements for reference applications.
  - Includes Multimedia Widgets, including 250 pre-scripted objects.
  - Uses a built-in recorder to translate actions into scripts which can be saved for re-use.
  - Includes hypertext hot words and buttons to link related ideas in text, audio, video, animation or graphics.

  - Has enhanced database capabilities.
  - Includes drawing tools for high-resolution color graphics.
  - Cost is approximately $700.

Section E

Hypermedia Advantages and Disadvantages

Hypermedia programs offer flexibility and a production system that can be effectively used in education and training. As with other technologies, hypermedia also has some disadvantages. The following tables detail hypermedia advantages and disadvantages.

Advantages	Impact
Inexpensive	In comparison with comparable computer software, hypmermedia programs are inexpensive $100 to $300, with discounts for educators and students. In many cases, the price includes the rights to distribute created programs.
Easy to learn	Sophisticated hypermedia programs can be created with fields, buttons, and graphic objects, without requiring the scripting component. With only a few hours invested, most users can create lessons and presentations.
Easy to store	Computer-based slide shows created with hypermedia are easy to store and modify.
Multimedia links	Hypermedia programs offer easy links to graphics, sound video, and CD-ROM.
Fun	Instructors have the power to create motivating, interactive programs.
Exportation and association	Hypermedia applications allow users to build their own associations between bits of information, based on their interests. Well-designed hypermedia programs can both motivate and assist students to explore a topic.

Disadvantages	Impact
Confusion	Poorly designed hypermedia programs can easily turn into hyperchaos, where the user has too many choices and gets lost. Research is continuing to determine the optimal number of selections per screen and the best methods to promote learning in a hypermedia environment.
Complex to learn at scripting level	Although the object level (buttons, fields, etc.) is relatively easy to learn, novices can quickly get lost and frustrated with scripting languages.
Difficult to project	One of the applications for hypermedia is to create interactive, dynamic computer slide shows. The problem is that many schools do not have the equipment to project the shows for presentations.
Platform-specific	Most hypermedia programs are generally restricted to one platform. If you create a slide show with the ToolBook authoring system, it will require an IBM computer with Microsoft Windows to run the program.
Delivery fees and files	In some cases, a developer may be required to pay a publication fee for delivery of an application. In other cases, the delivery files are free, but may be extremely large, making them difficult to distribute on floppy diskettes.

Chapter 8
COMPUTER NETWORKS

Introduction

The benefits of computer use can be multiplied in many organizations by linking individual computers into a network. These benefits normally include the sharing of files (more than one user can access the same information) and the sharing of software programs and printers. Most Air Force installations have computer networks, and many organizations, including education and training units, successfully use the base network and even some specialized networks devoted to their specific missions.

Managers' Network Concerns

Networking computers is a very technically demanding process. Most managers should not attempt to master the technicalities. Get the help of an expert, even an outside expert if necessary. Note also that decisions involving establishing or upgrading existing networks are major resource- and mission-impacting decisions. Costs range from a few hundred dollars to network all computers in an office to hundreds of thousands of dollars for complex networks for very high-speed data sharing by maximum number of users at several facilities. Managers need to get expert help for network design and the necessary cost analysis. However, the benefits of a well-designed, adequately supported network are often the measure of success in the successful use of computers to support education and training.

Terminology

Managers will benefit from a quick review of the common terms associated with computer networks.

- A **network** or **net**, for short, is a cable system that links individual workstation computers to each other through a central network server computer.

- A **local area network** or **LAN**, for short, is the network that links the individual computers in one building or on one base. LANs are limited by physical distance, by types of cabling available, and for practical reasons by the number of workstations served by the one network.

- A **workstation** is the user's computer. If attached to the network's centralized files capability, the workstation may lack its own storage capability. If the workstation is capable of processing and storing data independently of the network, the workstation is called a **stand-alone**.

- A **server** on the network is one computer that coordinates the operation of the network; the server is not available as a workstation. Most networks also have a second server, a **printer server** that allows all workstations on the net to share one printer.

In This Chapter

Though managers are not expected to be technical experts, knowing the basics of computer networks will assist in decision making in this area. To that end, this chapter covers these topics in the following sections:

Section A

Applications for Education and Training

Introduction

Although the initial investment in a school LAN can be high, the operation of a well- used, properly designed and maintained LAN will cost less over a period of time than will the operation of a group of stand-alone computers. LAN advantages include:

- Instructor monitoring of student work
- Developer access to software, files
- Student access to references, databases
- Group-study classroom projects
- School management enhancements

Monitoring Student Work

A properly configured network will allow the instructor to monitor each student's work. This provides feedback to the instructor and allows affirmations or further instruction for the student. Course materials can include tests at appropriate junctures, administered over the network, with tracking of individual scores and automated record keeping. When necessary, the student and instructor need not be in close proximity.

Assistance to Developers

Course developers, by sharing development software and reference materials and jointly developed files, can increase their productivity through use of a network.

Student Benefits

Students no longer have to relocate to access reference materials and databases previously available only by moving to a central location. The network serves as the bridge to the sources which can be shared by many students simultaneously.

Group Study Projects

Groups of students can be teamed to work computer-assisted projects. Team members can share text, graphics, and inputs from reference sources. The network allows the work to continue, even if the students are not in the same classroom.

School Management Enhancements

The network's linking of student machines with the instructor machine, and all machines with the administration office, can be used to automate many of the administrative functions required: grade/progress tracking and recording, attendance, time logged, references used, and so forth.

The purchase and control of software programs is also simplified by a network. A site license allows a centrally stored program to be shared with many users on the net. Some networks also have an automated means of inventorying all equipment connected to the net.

Section B

Network Technologies

Introduction

Most managers will not be directly involved in the design and installation of a computer network. The basic rule is get the expert involved. However, the manager will benefit from understanding the basic design, hardware and software presented in this section.

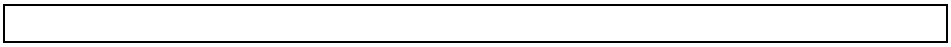


Figure 8. Examples of Network Design Topologies

Network Design Considerations

Two major considerations are notable:

Experts describe the design of a network as "topology," the shape it would take when illustrated on paper. Common topologies include the star, ring, tree, and line. Each has strengths and weaknesses, and the application of the network becomes the deciding factor. See Figure 8. Data speed, the rate at which different networks can transfer data, varies by network. When an expert can design higher data transfer rate into the network, more workstations can be used at the same time. Generally, the more users on a network, the slower the data transfer rate. However, many factors beyond number of users are considered by the experts.

Hybrid Design Networks

Computer network experts are likely to develop hybrids of the typology and cabling outlined above. Hybrids are often most effective, especially when location of workstation and servers, frequency of equipment change-out, and existing facility considerations are weighed.

Network Hardware Considerations

Beyond the computer workstations themselves, there are several hardware elements involved with networking. The most important are discussed below.

- The cabling that physically links the elements of the network is also a matter of design requirements and cost. For example, the total amount of cable required varies with the topology; but additional cable can create redundant paths so the network will remain operational even if one section of cable is damaged. A quick look at three common cable types, from least to most expensive, follows:

  - Twisted pairs. The wiring literally has two wires twisted together and is the same as that commonly used for telephone lines. If unused telephone lines exist in the building where the network is to be installed, they could be used to link computers. Twisted pairs are significantly vulnerable to interference that can disrupt the network.

  - Coaxial cable. This cable is very similar to that used for television signals. The same coaxial cable can support network and television signals simultaneously. Coaxial cable is almost immune to external interference. This cable is expensive.

  - Fiber optic cable. This cable has fine fibers of glass rather than metal wiring inside. Light, not electricity, is conducted. It offers very-high-speed data transmission, including video and audio capabilities in the same cable. It is immune to all forms of electrical interference because no metal is present. Fiber optic cable is very expensive, and difficult to install and modify.

- Network interface cards must be added to each computer in the network. The cards affect the topology, cabling, and data transmission of the network. Many networks are named for the cards. For example, one IBM network interface card package for a ring topology and token-passing data protocol is named "Token Ring." Other well-known packages are Ethernet and Arcnet. No two systems are directly compatible, but techniques do exist to bridge individual networks of different types.

- The file server is the computer that serves the network as both repository for all applications software programs and as traffic director for files going to workstations. Because of the critical role of the file server, there should be no compromising on file server features. IBM and compatible servers should be minimum 80386 central processor running at minimum of 33 megahertz. Macintosh systems should be Model SE-30 or higher.

- A printer server is the network's computer dedicated to managing the printing function between all computers and printers on the network. An older or minimum capability computer will normally handle the printer server duties.

- Workstations are standard computers with a network interface card installed and used by a worker. A hard disk drive on a workstation is redundant; the network server serves the purpose. However, workstations that require stand-alone capabilities will have hard disk drives.

Network Software

Network software requirements are in two categories:

- Management software. These programs include enhanced diagnostics, workstation monitoring, and automatic equipment inventory.

- Applications software. These programs include those available to support educational applications: computer-assisted instruction, word processing, database management, and other applications.

Network Software Licensing

Software programs come with a license that specifies the conditions under which it can be used. It is illegal to use software on a network unless specifically stated on the agreement. The software license will indicate how many users may use the software at one time.

Software Incompatibilities

Many single-user programs simply will not work on a network. Loading them will cause the work of multiple users to scramble.

Section C

Management Considerations

Careful Planning Required

Managers are reminded that the networking of computer systems brings both benefits and significant costs. The detailed input of a knowledgeable network designer is required and worth the investment.

Cost Considerations

In addition to the costs of the hardware and software requirements evident from the preceding sections, the following can add to or subtract from the initial and life-cycle costs of a network:

- Wiring and the labor costs to install it can be considerable. In an existing facility, present wiring in the form of unused telephone lines or spare-capacity television cables could be a major saving.
- Software change-over costs must be identified. If the unit has emphasized specific software in the past, determine the costs of changing it to a version that will be network-compatible. If it is not convertible, search further for hidden costs involved with converting existing data files and databases to the new network software.
- Most network costs are front-end-loaded. The budget definition process must adequately plan for the expenditure. A cost analysis will be most helpful.
- Network costs continue through the life of the network. Anticipate and budget for maintenance costs and upgrade costs which are predictable for the network system.
- Manpower considerations are also relevant. The basic activities of monitoring and upgrading a major network will require manpower, even it is only a few hours a day. Every network needs a resident manager.

Organizational Attitude

The importance of networking computers in an organization strongly suggests the forming of a planning team to consider the technological goals of the organization, work force considerations, and budgetary requirements. The benefits of the network to the organization should be well defined over the years of anticipated use.

Section D

Advantages and Disadvantages

The networking of computers effectively broadens the capabilities of the computer users. There are also potential disadvantages. The following tables detail the features and limitations of computer networks.

Advantages	Impact
Connectivity	No networks offer efficiency through connectivity. All network workstations can share hardware and software resources, including printers, programs and information in databases.
Centralized management of students	If computers are used in an instructional setting, the network allows a centralized approach to managing the learning process. A courseware management program allows an instructor to evaluate the progress of any learner. Notes can be left for individual students, and teachers can interact directly with students who are currently working on the network.
Control of software against pirating	Because all applications software programs are stored and managed through the file server, network management software controls access to the software. It is even possible to install diskless workstations that make it impossible to copy programs or to infect the system with computer viruses.
Ease of updating or adding software	Software is easy to update or change because only one copy of each program exists on the file server. Only the file server copy need be updated. All workstations use that single copy of the software.

Disadvantages	Impact
File server failure	Perhaps the greatest weakness in any LAN is that a failure in the file server will stop the whole system. Proper attention to LAN maintenance will prevent most serious problems from happening.
Cable damage	Problems with network cables can cause anything from minor interruptions to failures. Large, complex LANs might require complex diagnostic tools to locate and correct cable problems.

Daily system management	Networks need daily management. New users must be registered before they can use the LAN. Software must be updated or added on a regular basis. Minor problems with printers must be corrected before unmanageable backlogs of print requests accumulate. These are maintenance requirements to be planned for.
High initial installation cost	A network can be expensive to install. The apparent high price of a LAN can be misleading, though, because the actual cost of operating the same number of unconnected computers is usually even higher.

Chapter 9
TELECOMMUNICATIONS

Technology Quick-Look

Telecommunications is the process of transferring information electronically over distance. The following information applies:

- Telecommunications links computers to other computers beyond the local area network, even nationwide and globally.
- The electronic link is normally through telephone lines.
- Sending and receiving computers require modems (internal or external) and communications software.
- Modems have transmission rates and work with software protocols; the sending and receiving modems must be able to synchronize.
- Telecommunications has the ability to support and greatly expand the offering of education and training to students not present with the instructor.
- Telecommunications is changing the way Americans live and work and recreate.

Telecommunications Terminology

These terms are commonly used when discussing telecommunication systems:

- **Modem** is short for MOdulate/DEModulate. The devices convert computer data into audible tones that can be sent through telephone lines for another modem on the receiving end to convert back to computer data.
- **Baud rate** is the speed at which modems can send and receive data.
- Going **online** refers starting to the telecommunications process.
- **Logging on** is the initial connecting through a modem and phone lines to a distant computer. **Logging off** is the disconnection.
- **Downloading** is the process of bringing a file from the remote computer to your computer. **Uploading** is the process of sending a file to the remote computer.

In This Chapter

This chapter reviews the many applications and potentials of telecommunications and the technologies behind them. The information is presented in these sections:

Section A

The Telecommunication Technologies

The Basics

The field of telecommunications builds on computer technology. Simply stated, telecommunications is the outreach ability of computer systems. Telecommunications is the linking of computers remote from each other. As discussed in Chapter 8, local area networks link computers that are in close proximity.

Additional Technologies

The technologies that provide the outreach capabilities include:

- Modems
- Software protocols
- Facsimile transmission
- Hybrid fax and modem systems

How Modems Work

The only equipment needed to connect a computer to a standard telephone line is a modem. The term is derived from **MO**dulation /**DE**modulation. The modem can be an internal card in the computer or an external device cabled to the computer and the phone line. A modem accomplishes two tasks, respectively known as modulating and demodulating:

- **Modulating**. Conversion of computer digital information into an analog-based fluctuating tone capable of moving through telephone lines.
- **Demodulation**. Receiving the fluctuating tone inbound through telephone lines and converting the tone into digital computer data.

Computer Long-Distance Calling

Telecommunications is long-distance calling for computer systems. The distance between sending and receiving computers and their modems is inconsequential.

Variations in Modem Trans-mission Rates

Improvements in modem and telephone line technologies over the past decade led to significant increases in the speed of modems. The faster the transmission rate, the shorter the long distance time involved, and the lower the cost of telecommunicating. Transmission rates were originally rated in "baud," a complex measurement. The higher the baud rate, the more data transmitted per second. The baud rating of modems has been replaced by the "bits per second" measurement, or "bps."

Bits Per Second

A bit is a binary digit, having a value of either 0 or 1. Computers use bits to define and separate characters, about 10 bits for a single character of information (including start and stop bits). A modem with a transmission rate of 1200 bps will transmit about 120 characters per second. Transmission rates continue to increase; 9600 bps modems are not unusual. (Example: this block of information on bits per second is 479 characters/spaces long. It could be transmitted by a 1200 bps modem in about 3.99 seconds.)

Software Protocols

As two computer modems exchange information, the computers "handshake" with each other to ensure that the information can be translated successfully. This exchange of protocols includes agreement that certain bits represent the start and end of characters, that the number of bits in each character is understood, that no errors have been introduced in the transmission, and that the receiving modem and computer are ready to receive the data. Most software programs and modems accomplish the handshake automatically.

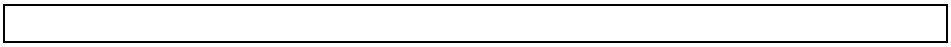


Figure 5Figure 9. The Modem-Telephone Line-Modem Configuration for Telecommunication Between Computers

Facsimile Transmission Technology

Facsimile machines, popularly called "faxes," are used to send copies of paper documents from one location to another. The fax machine operates much like a modem, generating tones sent over telephone lines. There is a major difference: fax tones do not represent actual characters of information. They represent only areas of light or dark on the original document. A graphic copy of the original is reproduced on the receiving end, and although it appears to be text, it is not. However, the receiver cannot feed the information thereon directly into a computer.

Hybrid Fax/Modems

Recent advances have created fax/modems that:

- Can send data files to be received as an image on the distant fax machine.
- Can receive a fax image and, with proper software, store the image, print it, or display it on the computer screen.
- Cost little more than standard modems and, therefore, may be good investments if fax capability is needed but fax machines are not already available.

Fax/Modem Limitations

The user must remember that fax images remain image data and cannot be translated into text files by a computer. Text files can be converted into images for sending to a fax machine, but when received they are images and not text files.

Section B

Telecommunications Applications

The Impact of Telecommunications

Telecommunication technologies have impacted every American and most people of the world. The following are common examples of telecommunications technology applications.

- Television broadcasts can be taped for convenient viewing.
- Telephone messages no longer require direct contact with callers; answering machines save communicated messages.
- Research of information sources does not end when libraries close or office staffs go home; electronic databases are accessed all hours of the day.
- Personal and business written messages can be delivered electronically, never going through the postal system.

Advantages for Education and Training

Although not developed specifically for education and training applications, telecommunications technologies have significant benefits for educators and trainers. If considered as tools, these technologies offer gains in productivity, effectiveness, and even enjoyment to all levels of education training. One of the greatest benefits is the ability for the computer-capable person to reach out, capture and use an endless array of materials, information, and professional contacts.

Telecommunication Applications

The technologies have been shaped to develop and make available the following tools and systems:

· E-mail. Electronic mail is familiar to most office workers as a communication means to quickly exchange information with co-workers on the local area network to which their computers are linked. If the users think globally, E-mail systems can also be linked through modems to any other computer, no matter its location, if the receiver has a modem and is connected to the telephone system. Messages, even lengthy files to be shared, can be delivered almost immediately to one or several individuals. Time, postage and telephone costs are minimized.

· Bulletin boards. Similar to all bulletin boards, electronic bulletin boards offer many of the same functions:

·· Extension of E-mail. Messages can be posted for pick-up by any interested reader with access to the board.

·· Conferencing. Most bulletin board services have people designate conferences, or areas of interest, for which they want to receive information.

·· File transfers. Files can be uploaded to the bulletin board for downloading by board users. This can be a most effective distribution system. One caution: copyright considerations must be strictly followed. Uploading and downloading copyrighted files to a bulletin board can constitute pirating, theft of the property. Bulletin board users must also guard against the possibility of downloading viruses with files brought into their computers.

·· Database access. Many bulletin boards allow users to access specific databases. Examples include course offerings, library holdings, and public records. The bulletin board will activate the appropriate software when requested.

·· Doors. This term refers to an access path by which users can run software other than the actual bulletin board. This allows running the software and seeing the results before deciding to go through the download process.

· Remote computing with mainframes. Personal computers and modems have completely changed the way many people use mainframe computers. Terminal emulation software has been developed to link personal computers to mainframe computers. With the use of modems, the personal computer can be remote from the mainframe computer. This allows personal computer users to access the greater computing power and stored data of the mainframe. It also allows companies to consider having their employees work where convenient, even at home, and to access the company mainframe for downloading and uploading their work elements. Similarly, researchers from their personal computers can continue to use the search capabilities and databases of mainframe facilities around the clock.

· Online services. Some companies are in the business of providing online service to individual subscribers. Subscribers use their personal computers and modems at home, office or school to connect to the company's mainframe computer. There are two categories of services:

·· Database online services. These vendors create a front end means of access to a variety of commercial indexes, bibliographies, or other databases. Consumers use the company's user-friendly search interface to get the needed information. The charges for the service go up to $300 an hour. DIALOG is perhaps the best known of the database online service vendors.

·· Integrated online services. These vendors offer, usually through monthly fee arrangements, a multitude of consumer-oriented services. Personal computer users can access current news, E-

Section C

Review of Teleconferencing Technologies

Status of Teleconferencing

Teleconferencing is the use of telecommunications technology to link two or more sites for interactive passing of information. Teleconferencing is growing as a support service for the distribution of learning programs. Capabilities available today are generally in three categories.

- Audio teleconferencing. The most mature of the techniques, audio teleconferencing requires little equipment. Its major drawback is that the lack of visual interaction requires planning to keep the educational process productive.

- Audiographic teleconferencing. This variation allows figures, charts, and still pictures to be exchanged during the conference. Computer and fax technologies are used for interactive exchange of images, thus enhancing the free expression of ideas.

- Video teleconferencing. This technique combines full-motion video with audio. Most forms of video teleconferencing still require careful cost justification in education uses, but costs are declining.

Comparison of Teleconferencing Techniques

Teleconferencing has progressed to the point that it can be an effective addition to education and training, especially when instructors are fewer in number and students are dispersed worldwide. The following table summarizes the features of teleconferencing techniques.

TELECONFERENCING TECHNIQUE

	Audio	Audiographic	Video
Features	2-way audio	2-way audio 2-way still images	2-way audio 1-way video images
Course Content	Highly Verbal	Verbal/Visual	Visual
Teacher Training	Slight	Moderate	Extensive
Planning	5 days	1 month	1 year
Class Location	One or many sites	Two sites	One or many sites
Student Interaction	Verbal	Verbal or still image	Verbal or video
% of Total Class Time	10-15	30-60	75-100
Relative Costs	Low	Moderate	High

Representative Costs

About 100 corporations in the United States have invested in corporate video teleconferencing for frequent use. The requisite equipment can fit on a cart that can be rolled from classroom to classroom or between offices. Included are a video camera, monitor, video compression-decompression system, and an interface for connecting to a telephone line. Cost as of late 1993: $50,000 to $70,000. Anticipated 1994 cost: $20,000 to $30,000.

Prices for "switched telecomm" services over a dial-up network, digital video-capable personal computers, is forecast as $15 to $20 for an hour of coast-to-coast time in 1995. The two PCs will cost under $10,000 (Haber, 1992).

Educational Applications

Education and training managers, developers, and instructors have successfully applied teleconferencing to needs that justified the time and cost requirements. As these costs continue to decline, additional use of teleconferencing will be seen for these applications:

- Guest speakers. Adding subject matter experts to class discussions, without requiring the expert to travel to the school.
- Homebound or remotely based students. This connects the classroom and students unable to attend classes.
- Distance tutoring. This connects tutors and students who need additional assistance, even if after class times.
- Distributed classrooms. Connecting several classroom sites to a location where the teacher is available is often a cost-effective delivery means. Teleconferencing takes place at a prearranged time for interaction between instructor and students.
- Distributed classes. Often used for adult students who cannot be gathered for same-time classes. Individual students or groups of students at a site gather to work with taped programs.
- Contract courses. Specialized courses or those with a scarcity of teachers are often provided through contracting with outside companies. These courses are often delivered via satellite television with audio teleconferencing for student interaction.

Attachment A - Air Force ISD Documents

AFPD 36-22, Military Training

AFI 36-2201, Developing, Managing, and Conducting Military Training

AFI 36-2301, Professional and Military Education

AFMAN 36-2234, Instructional System Development

AFMAN 36-2236, Handbook for Air Force Instructors

AFH 36-2235, Information for Designers of Instructional Systems (11 volumes)

Vol 1, Executive Summary

Vol 2, ISD Automated Tools/What Works

Vol 3, Application to Acquisition

Vol 4, Manager's Guide to New Education and Training Technologies

Vol 5, Interactive Courseware (ICW) Design, Development and Management Guide

Vol 6, Guide to Needs Assessment

Vol 7, Design Guide for Device-based Aircrew Training

Vol 8, Application to Aircrew Training

Vol 9, Application to Technical Training

Vol 10, Application to Education

Vol 11, Application to Unit Training

Attachment B - Bibliography

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Attachment C - Abbreviations

ADC	Analog-To-Digital Converter
BBS	Bulletin Board System (see also EBBS)
BPS	Bits Per Second
CAV	Constant Angular Velocity
CD	Compact Disc
CD+G	Compact Disc Plus Graphics
CD-I	Compact Disc Interactive
CD-ROM	Compact Disc-Read Only Memory
CD-ROM	Compact Disc-Read Only Memory
XA	eXtended Architecture
CDTV	Commodore Dynamic Total Vision
CGA	Color Graphics Adapter
CLV	Constant Linear Velocity
DAC	Digital-To-Analog Converter
DVI	Digital Video Interactive
EBBS	Electronic Bulletin Board System (see also BBS)
EGA	Enhanced Graphics Adapter
Hz	Hertz
I/O	Input/Output
IVD	Interactive Videodisc
kHz	Kilohertz
LCD	Liquid Crystal Display Panel
MIDI	Musical Instrument Digital Interface
NT SC	National Television Systems Committee
OCR	Optical Character Recognition
WORM	Write Once-Read Many

Attachment D - Definitions

Access Time. Time required to find and display information. Most CD-ROM drives have access times between 0.5 and 1.5 seconds.

Analog Recording. Recording method in which the waveform of the recorded signal resembles the waveform of the original signal.

Analog Video. Video that is stored as an electrical signal with a continuous scale. Videotape and videodisc generally store analog video.

Archiver. Program that performs compression and decompression on files. Archivers are common in telecommunications.

Arcnet. Common network standard, recently standardized, but in use since 1977. Uses a token-passing protocol. Common transmission speed is 2.5 megabits per second.

ASCII (American Standard Code for Information Interchange). Established code that defines all characters, punctuation marks, and digits in binary form.

Audio Chip. Computer chip that can produce sounds.

Audio Track. Recorded narration, sounds, and music. Videodiscs usually have two audio tracks, which can be accessed independently or in stereo.

Authoring System. Computer program designed specifically to create computer-based instruction.

Background. Every hypermedia card is made up of two layers, the background and the foreground. The background layer can be shared by many cards to enhance consistency and minimize duplication of buttons, graphics, etc.

Barcode. Small parallel lines that can be read and interpreted by a scanner (barcode reader). Barcodes can contain instructions for the videodisc player.

Barcode Reader. Pen-like wand used to read barcodes from paper. Some barcode readers are used as remote controls for a videodisc player.

Baud Rate. Speed at which binary (computer) data is transmitted. Common baud rates are 1200, 2400, 4800, and 9600. Also see **Bits Per Second**.

Bit (BInary digiT). Basic unit of computer information expressed numerically as O-zero or 1.

Bits Per Second. Modern method of measuring the speed of a modem. Modems range in speed from 1200 bits per second (bps) to over 19,000 bps. Modems must be matched to the same bps rate before they can communicate with each other.

Branch. Movement from one location of a program to another. For example, if a button initiates a videodisc sequence, it is said to *branch* to video.

Bridge. Network computer that links two similar networks.

Browse. In hypermedia, use of a completed hypermedia stack.

Bulletin Board. Electronic bulletin board system (EBBS, sometimes shortened to BBS). A computer-based equivalent of the traditional bulletin board. Most EBBS systems also offer an option for private E-mail.

Button. Object in hypermedia used to initiate an action, such as a branch to another card or a videodisc sequence.

Byte. Grouping of eight bits. A byte provides sufficient information to define one ASCII character.

Cable. One or more conductors contained within a protective shell.

Capture. Most telecommunication software allows you to save (*capture*) data to a disk. This makes it possible to review or use the results of a telecommunication session at a later time.

Card. Basic entity of hypermedia, equivalent to one screen of information.

Channel. Paths over which MIDI (Musical Instrument Digital Inteface) information travels. MIDI can send data on as many as 16 channels with a single MIDI cable.

Coaxial Cable. Cable made up of one central conductor surrounded by a shielding conductor.

Color Graphics Adapter (CGA). Graphics display adapter for IBM-compatible computers that can display four colors simultaneously.

Commodore Dynamic Total Vision (CDTV). Multimedia delivery system by Commodore that combines digital audio, graphics and video on a compact disc. CDTV has a wide range of capabilities and is focused on the consumer market.

Compact Disc. Plastic platter 4.72 inches wide that stores digital data or music, encoded and read by laser beam. Sometimes called *optical* discs.

Compact Disc Audio (CD audio). Popular format for high-fidelity digital music. Each disc offers 74 minutes of programmable sound with no degradation of quality during playback.

Compact Disc Interactive (CD-I). System specification for an interactive audio, video and computer system based on compact disc as the storage medium. CD-I has a wide range of capabilities and is focused on the consumer market.

Compact Disc Plus Graphics (CD+G). Compact disc with limited graphics to complement the music.

Compact Disc-Read Only Memory (CD-ROM). Prerecorded, nonerasable disc that stores over 650MB of digital data.

Compact Disc-Read Only Memory eXtended Architecture (CD-ROM XA). Special CD-ROM disc that interleaves the audio with the graphics/text.

Compression. Reduction of a signal's output level in relation to its input level to reduce storage requirements.

Conference. Bulletin board (on an electronic bulletin board system) labelled for specific topics. A number of conferences may be available, and users select those in which they are interested.

Connect Time. Amount of time a computer is connected to a telecommunication service, such as a BBS or an online database. Charges are often based on connect time.

Constant Angular Velocity (CAV). Videodisc format that allows the user to address each frame separately. It can store a maximum of 30 minutes of motion on each side.

Constant Linear Velocity (CLV). Videodisc format that can store 60 minutes of motion on each side. This format cannot display an individual frame.

Data Bit. Number of bits used to define one character of information during telecommunications. Most BBS systems use eight data bits to define each character.

Dedicated Telephone Line. Normal telephone line that is reserved for telecommunications.

Dialog Box. Window that asks a question or allows users to input information.

Digital Recording. Method of recording in which samples of the original analog signal are encoded as bits and bytes.

Digital Video. Video stored in bits and bytes on a computer. It can be manipulated and displayed on a computer screen.

Digital Video Interactive (DVI). Technology for compressing and decompressing video and audio to create multimedia applications. DVI can store 72 minutes of full-motion video on a compact disc.

Digitizing. Process of converting an analog signal into a digital signal.

Disc. Usually, a videodisc or compact disc. Computer diskettes are electromagnetic and referred to as *disks* (with a "k"). Videodiscs and other optical storage media are referred to as *discs* (with a "c").

Door. Technique used by some bulletin board systems to let users run programs on the host computer and see the results on their own computers. The actual program is not downloaded when a door is used.

Download. Process of copying a file from a storage medium (such as CD-ROM) to a computer diskette or hard drive.

Echo Mail. Network of bulletin board systems that transfers mail from system to system.

Electronic Mail (E-mail). Mail or communications sent and received through electronic, nonpaper methods. Usually a mainframe, a LAN, or a BBS is the vehicle.

Enhanced Graphics Adapter (EGA). Graphics display adapter for IBM-compatible computers that can display 16 colors simultaneously with a resolution of 640 x 350. EGA adapters have better resolution than CGA, but less resolution than VGA.

Ethernet. Network communications standard developed by Xerox. Data transmission speed is typically 10 megabits per second.

Fiber Optic Cable. Cable that contains a fine strand of glass-like material. Light, not electricity, is conducted through the cable.

Field. Object in hypermedia designed to hold textual information.

File Server. Network computer that stores and distributes the files for the workstations.

Foreground Layer. In most hypermedia programs, screens have two layers, the background and the foreground. The foreground layer is unique to each screen and cannot be shared. Generally, the foreground layer is viewed as being *transparent*—any objects on the background layer will show through the foreground layer.

Frame. Single, complete picture in a video recording.

Frame Grabber. Device that converts a single analog video frame into digital format to store on a hard drive.

Frame Number or **Address.** Each frame on a videodisc has a unique number between 1 and 54,000. These numbers can be used to access the frame with the remote control, barcode reader, or computer.

Frame Rate. Number of video frames displayed each second.

Freeze Frame. Display of a single frame that was originally produced as part of a motion sequence.

Frequency. Number of times per second that a sound source vibrates. Frequency is expressed in hertz (Hz) or kilohertz (kHz).

Full-Motion Video. Display of video frames at 30 frames per second.

Handshake. Modem settings that must be matched before two computers can communicate through the modems.

Hertz (Hz). Unit of measurement of frequency; numerically equal to cycles per second.

Host Computer. Computer that is called when initiating telecommunications; may be a mainframe, LAN, BBS, or personal computer.

Hypermedia. Delivery of information through multiple connected pathways. Hypermedia allows users to branch seamlessly between text, graphics, audio, or video.

Hypermedia Program. Software program that provides seamless access to text, graphics, audio and videodiscs.

Icon. Symbol that provides visual representation of an action or other information. An icon of an arrow is often used to denote directional movement in hypermedia.

Image. Graphic, picture, or one frame of video.

Interactive Videodisc (IVD). Generally refers to Level III interactivity, in which a computer is used to control the videodisc player.

Interface. Link between two components, such as a CD-ROM player and a computer.

Interface cable. Cable that connects a computer and peripheral hardware.

Internet. Electronic mail system connecting governmental institutions, military branches, educational institutions, and commercial companies. There is no surcharge to use Internet. The new name for Internet is National Research and Education Network.

Kilohertz (kHz). Unit of measurement of frequency equal to 1,000 hertz.

Level I Interactivity. Interactivity achieved when the videodisc player is controlled through the player, a remote control, or a barcode reader. The player is not connected to a computer.

Level II Interactivity. Interactivity achieved when the videodisc contains a control program as well as the video material. The player is not connected to a computer.

Level III Interactivity. Interactivity achieved when a computer is used to control the videodisc player.

Link. Connection from one place or medium to another. For example, buttons contain the linking information between cards in hypermedia.

Liquid Crystal Display (LCD) Panel. Panel that connects to a computer to display the computer screen when placed on top of an overhead projector.

Local Area Network (LAN). Interlinked microcomputer system, the dimensions of which are usually less than two miles. Transmission rates are usually above one megabit per second.

Logoff. Simple command typed to tell the host computer that the user is finished.

Logon. Procedure followed to start a telecommunication session. Often it requires the user to enter a name and a password.

Megabit. One million bits.

Modem (MOdulator-DEModulator). Device used to link computers together through telephone lines. *Modulation* is the process of changing computer data into tones that can be sent through a telephone line, and *demodulation* is the process of changing the tones back into computer data.

Monitor. Visual display device capable of accepting both video and audio signals.

Musical Instrument Digital Interface (MIDI). Standard for communicating musical information among computers and musical devices.

Multimedia. Programs that combine more than one media type for dissemination of information. For example, a multimedia program may include text, audio, graphics, animation and video.

National Television Systems Committee (NTSC). Committee that formulated the United States television standard of 525 horizontal lines per frame at 30 frames per second.

Network Interface Card (NIC). Interface card added to a computer to make it a network workstation; determines the standard for the network cable. Common standards are Arcnet, Ethernet, and Token Ring.

Object. In hypermedia, generally refers to an element placed on the screen, such as a button, field, or graphic. Objects are components that can be manipulated and can contain links to other objects.

Online. Having a computer connected via modem and telephone lines to another computer.

Optical Character Recognition (OCR). Software that enables a scanner to recognize individual letters or words. Text that is scanned with OCR software can be imported and manipulated by a word processing program.

Optical Disc. Disc encoded and read with a beam of light. Usually refers to a compact disc or video disc.

Optical Media. Media read with a laser beam. CD-ROM and videodisc technologies utilize optical media for storage.

Overlay. Ability of a computer and monitor to place a computer-generated graphic on top of a video display.

Packet. Grouping of binary digits, often a portion of a larger file. Treated within a network as an entity.

Peripheral. Hardware controlled by a computer.

Photo CD (Photographic Compact Disc). Disc used by Kodak to store photographic images.

Pixel. Single dot or point of an image on a computer screen. *Pixel* is a contraction of the words "picture element."

Printer Server. Network computer that runs software to control one or more shared printers.

Protocol. In telecommunications, complete structure of information going from one modem to the other. Data speed in bits per second, error checking, the number of start bits, the number of data bits, and the number of stop bits all constitute the protocol. The same settings must be used in both computer modems.

QuickTime. File format that allows Macintosh computers to compress and play digitized video movies.

Receiver. Visual display device capable of receiving and displaying a broadcast signal.

Repurposing. Using a videodisc for a purpose other than the one originally intended, usually to upgrade interactivity.

Resolution. Sharpness or clarity of a computer screen. Monitors with more lines and pixels of information have better resolution.

Rewritable Compact Disc. Computer drive that allows the user to write, erase and rewrite on a compact disc (a developing technology).

Sampling Rate. Number of intervals per second used to capture a sound when it is digitized. Sampling rate affects sound quality; the higher the sampling rate, the better the sound quality.

Scan. Mode of play in which the player skips over several frames at a time. Scanning can be done in forward or reverse.

Scanner. Hardware peripheral that takes a "picture" of a hard-copy graphic and transfers the image to a computer.

Scripts. Series of commands written in a language embedded in a hypermedia program.

Slide Show (Electronic). Computer screens designed in a sequence for projection purposes. Many hypermedia programs provide transitional effects for these sequences (such as dissolves or wipes).

Stack. In hypermedia, a group of cards in the same file, usually based on the same theme.

Step Frame. Function of a videodisc player that moves from one frame to the next (can be forward or reverse).

Still Frame. Single video frame presented as a static image (not part of a moving sequence).

Still Video. Camera that stores pictures on a small diskette instead of film. The pictures can be displayed on a video monitor or can be digitized and displayed on a computer.

Synthesizer. Musical instrument or device that generates sound electronically.

Telecommunication Software. Program used to allow the computer to communicate through a modem. Most software of this type dials the requested number and sets the modem for the system being called.

Terminal Emulation. Most mainframe computers are designed to communicate with specific workstations called *terminals*. For a microcomputer to communicate with a mainframe, the microcomputer telecommunication software must be able to perform like, or *emulate*, an appropriate terminal.

Token Ring. Network standard that uses a ring topology with token-passing techniques to prevent data collisions. Transmission rates are 4 or 16 megabits per second, depending upon interface cards and type of cable.

Toolbox. Menu component in hypermedia programs that contains tools to create graphics.

Twisted-Pair Cable. Two wires twisted together. This type of cable is often used for telephone communications.

Upload. Process of sending a complete file to the host computer.

Video Graphics Array (VGA). Graphics display adapter for IBM-compatible computers that can display up to 256 colors simultaneously with a resolution of 640 x 480 pixels.

Waveform. Shape of a sound depicted graphically as amplitude over time.

Window. Area on a computer screen that displays text, graphics, messages, or documents.

Workstation. Unit, consisting of a computer and peripherals, used to deliver lessons or provide a work area.

WORM (Write Once-Read Many). Special technology that can record (but not erase) a compact disc.